ANALYSIS AND MODELING OF MOTOR VEHICLE CRASHES INVOLVING

AIR FORCE MILITARY PERSONNEL

THESIS

Antonios Markopoulos, First Lieutenant, HAF

AFIT/GCA/ENV/09-S01

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GCA/ENV/09-S01

ANALYSIS AND MODELING OF MOTOR VEHICLE CRASHES INVOLVING AIR FORCE MILITARY PERSONNEL

THESIS

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Cost Analysis

Antonios Markopoulos, MS

First Lieutenant, HAF

September 2009

AFIT/GCA/ENV/09-S01

ANALYSIS AND MODELING OF MOTOR VEHICLE CRASHES INVOLVING

AIR FORCE MILITARY PERSONNEL

Antonios Markopoulos, MS

First Lieutenant, HAF

Approved:

______________//signed//__________________________ 21 August 2009
Jeremy M. Slagley, Maj, USAF (Chairman) Date

______________//signed//__________________________ 17 August 2009
David A. Smith, Lt Col, USAF (Member) Date

______________//signed//__________________________ 13 August 2009
David M. Kaziska, Maj, USAF (Member) Date

AFIT/GCA/ENV/09-S01

Abstract

The primary purpose of this thesis was to improve the data analysis of Motor Vehicle Crashes (MVCs). This thesis employed the Air Force Safety Center (AFSC) data, collected over 20 years, of MVCs in which US Air Force (USAF) military personnel are involved when off duty and off base. Categorical Data Analysis and Analysis of Variance (ANOVA) were applied to identify risk factors related to MVCs and influence the severity of injuries and those factors associated with the alcohol consumption before driving, and affect the number of lost workdays resulting from MVCs.

Categorical Data Analysis showed that male USAF members aged 17-24 years or with the rank of Airman were more prone to experience a fatal MVC. Moreover, fatal MVCs peaked between the hours of 2200 pm to 0559 am, and USAF female drivers seemed to wear seatbelts more than USAF male drivers. These thesis results revealed the value of wearing seatbelts for the prevention of severe injuries during crashes. Finally, ANOVA results exposed that the more severe the Type of Injury, the greater the number of Lost Days and that 2-wheeled vehicle MVCs have the most significant effect on the number of Lost Days.

To my eldest cousin and myself

Acknowledgments

I would like to express my sincere appreciation to my thesis advisor, Maj Jeremy M. Slagley, for his guidance, support, and latitude provided to me throughout the course of this thesis effort. I am equally indebted to the members of my thesis committee, Lt Col David A. Smith and Maj David M. Kaziska for all of their mentoring. Their insight and experience was certainly appreciated. Additionally, I should thank my program directors Lt Col Jeffrey S. Smith and Lt Col Eric J. Unger for their behind the scenes contribution.

I would also like to thank Thomas L. Schultz, Bruce R. Burnham and CMSgt Robbie B. Bogard, AFSC and Maj Nathan P. Sherman, AF/A1PF who spent their valuable time explaining the processes and providing useful information and data that I needed to carry out this research.

Special thanks for their support and love go to Annette R. Robb, the Director of the International Student Office at AFIT, and to my host family in the United States. I should not forget to express my sincere appreciation to my country and more specifically to Hellenic Air Force for this opportunity.

Finally, and most importantly, my deepest gratitude and love goes to my parents for their patience and support during my whole life. Their efforts and sacrifices were not wasted.

Antonios Markopoulos

Table of Contents

Page

Page

Page

Page

List of Figures

Page

Page

Page

List of Tables

Page

ANALYSIS AND MODELING OF MOTOR VEHICLE CRASHES INVOLVING AIR FORCE MILITARY PERSONNEL

I. Introduction

Background

Universally, road networks offer people a high level of mobility essential for improved quality of life, national economic growth, and development. Road network construction also limits the isolation of cities and regions. However, road networks are one of the most significant places in which millions of people, especially those in younger age groups, are involved in Motor Vehicle Crashes (MVCs) resulting in fatalities and a multitude of injuries. According to World Health Organization (WHO) statistics, 1.2 million people are killed on roads every year and up to 50 million more are injured (WHO, 2008). Annual fatalities due to MVCs are expected to reach 2.4 million by the year 2030 and to increase from the 9th cause of death in 2004 to the 5th cause by 2030 (WHO, 2008: 29-30).

The private motor vehicle is the primary means of personal transportation in our world. Unfortunately, since people have to operate a motor vehicle in their everyday lives, in order to travel to work, school or vacation, to visit friends, to go shopping or for general enjoyment and relaxation, they put themselves at a high risk of being involved in a MVC.

The United States (US) has enormous and rambling road networks that not only provide an unprecedented degree of mobility for its citizens and visitors, but also a high risk of MVC occurrence. The US is one of the countries that face this social problem at a serious and alarming level. According to the "Traffic Safety Facts Annual Report" issued by the National Highway Traffic Safety Administration (NHTSA), from Fiscal Year (F.Y.) 1997 to F.Y. 2006, the US had on average, 6.3 million MVCs, 42,300 deaths and 2.9 million injuries per year.

MVCs and their regrettable consequences are one of the gravest issues that the Military Services and the Department of Defense (DoD) have faced for many years now. MVCs are the leading cause of fatalities among the members of the Military Services (DoD, 1999: 2-35, 2-45, 2-55; 2-65). Based on US Air Force Safety Center (AFSC) data, during the period from F.Y. 1988 until F.Y. 2007, the US Air Force reported 12,403 Private Motor Vehicle (PMV) mishaps in which US Air Force military personnel had been involved when off duty and off base. These mishaps have left 1,104 people dead, 242 people completely or partially disabled, and 12,088 people with various types of injuries.

Without taking into account the number of lost workdays which have been caused by the fatalities and the cases of permanent total or partial disability, the above number of PMV mishaps resulted in 152,252 lost workdays, of which 52,398 were hospitalization days. Also, the AFSC estimation of the total direct costs for these crashes is about $417 million.

First of all, MVCs fatalities and injuries influence the victims' lives, their families, friends, the military and society. Each and every MVC in which an airman is involved, independent of its direct consequences, negatively affects Air Force power and capacity to fulfill missions. Lost productivity due to workplace disruption and additional costs for medical and rehabilitation services are some of the MVCs' consequences which not only affect the Air Force budget but also have a financial impact upon the taxpayers.

MVCs are complex events and rarely can a single cause of such an incident be found. MVCs are the result of a combination of factors such as human factors, roadway environment factors, and vehicle factors. The age, the gender and the comparative experience, or lack thereof, of the driver, speeding and other traffic violations, as well as driver impairment such as the effect of alcohol or other drug abuse are some of the human factors that can cause a MVC. Furthermore, driver inattention or failure to use occupant protection systems such as a safety belt or motorcycle helmet, and an aberrant driver's behavior can influence the risk of a MVC event and injury severity.

Following human factors, the roadway environment is the 2nd most prevalent factor contributing to MVCs. According to the General Accounting Office (GAO) the roadway environment includes the design of the roadway, roadside hazards, and the roadway condition (GAO, 03-436: 20). Finally, the factor which is believed to contribute less towards MVCs than driver or roadway environment factors is the vehicle. More specifically, the vehicle factor is associated with vehicle related failures and vehicle design including size and safety characteristics (GAO, 03-436: 26-32 & Evans, 1991: 64-95).

MVCs impact both the injured party and the broader society. In addition to the victims and their families, friends and employers are affected by MVCs in many ways. Unfortunately, in addition to fatalities or injuries and property damages; burdensome economic costs and various psychological outcomes are usual consequences after MVC events (WHO, 2004: 47-51 & NHTSA, 2002; 809-446). These economic, psychological and emotional problems can change the victim's life dramatically with harmful consequences for the individual victims, their families and their friends (NHTSA, 2002; 64 – 69).

The WHO estimates that without increased accident-reduction efforts and new safety initiatives, the total number of MVC fatalities and injuries will increase universally by 65% by 2020 in comparison with the current dispiriting MVC figures (WHO, 2004: 3). The US Air Force, through the AFSC, issues numerous regulations and has put into practice several intervention programs. One of the most popular US Air Force intervention programs is the “101 Critical Days of Summer” campaign. This program was developed to suppress the increase in Air Force’s mishaps and deaths that occur during the period between Memorial Day and Labor Day of each year.

The 2008 US Air Force “101 Critical Days of Summer” program included a campaign with a video in which the top Air Force safety officer advised the Air Force personnel on motor vehicle safety topics. According to Maj. Gen. Wendell Griffin’s speech in the “101 Critical Days of Summer” 2008 campaign video:

> “Each year the US Air Force loses more people in MVAs than any other mishap type.”

He continues:

> “In 2007 the Air Force lost nineteen people during the 101 critical days of summer, eight of those deaths involved automobiles and each one was preventable.”

Unfortunately, similar mishaps were not prevented for summer 2008 and Airmen losses caused by MVCs were once again unsettling. Through the 101 critical days of 2008 the Air Force lost sixteen airmen and eight of those were from MVC fatalities (AFSC, 2008).

Considering the high rate of MVCs around the world and specifically amongst US Air Force military personnel, the colossal costs, both direct and indirect, and so many other grievous effects that MVCs have on victims, their families, friends and country, it is imperative for Air Force policymakers to take more precautions and apply more intervention programs in order to reduce the rate of MVCs. US Air Force supervisors at all levels must try to improve their personnel' s sense of personal responsibility and readiness, so as to prevent mishaps caused by MVCs, mitigating lost workdays, and operational costs, fatalities and injuries.

The main purpose of this thesis is to attempt to improve the data analysis of MVCs in which Air Force military personnel are involved when off duty and off base, to attain information that can help US Air Force policymakers to make better decisions and apply more effective intervention programs to combat the MVC tragedy.

Problem Statement

The high frequency of MVC occurrences and the considerable costs they cause affect the operational readiness and productivity of US Air Force military personnel. Figure 1 depicts some of the results of the Headquarters AFSC Research and Epidemiology Branch (SEAR) study (AFSC, 2007).

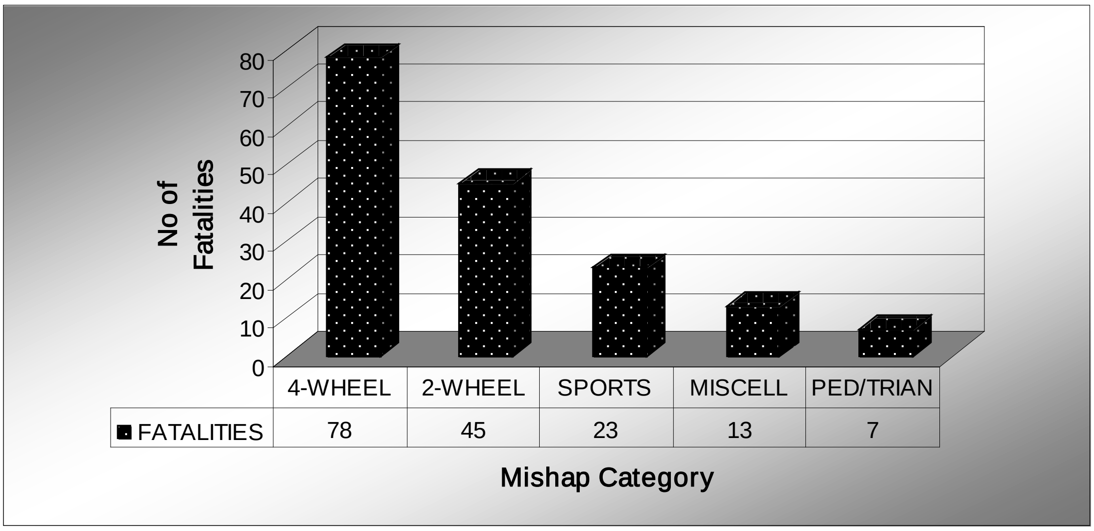

Figure 1. The US Air Force Ground Off-Duty Mishap Fatalities per Mishap Categories from Fiscal Year (F.Y.) 2005 to F.Y. 2007

Based on this study, almost 75% of the Air Force ground off-duty deaths from F.Y. 2005 to F.Y. 2007 involved 4-wheel or 2-wheel motor vehicles.

According to the NHTSA's research note, in 2005, MVCs were the leading cause of death for United States citizens age 3 through 6 and 8 through 34 (NHTSA, 2008; 810-936: 1-2). Figure 2 presents the MVCs' fatalities by rank from F.Y. 2003 to F.Y. 2007 according to AFSC data.

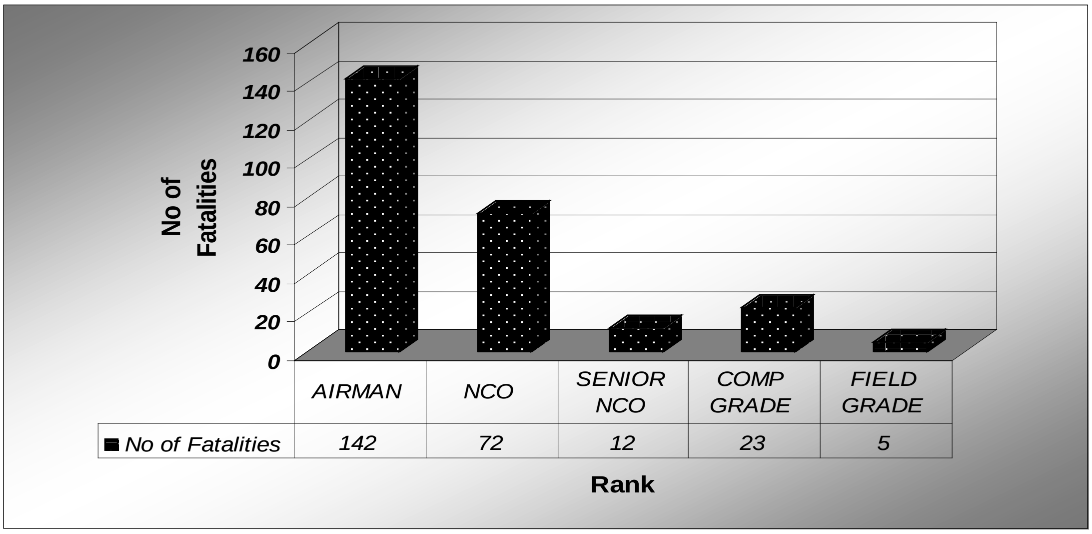

Figure 2. The US Air Force MVC Fatalities by Rank from F.Y. 2003 to F.Y. 2007

In accordance with the AFPC demographics snapshot, the average age of the officer force is 35 and the average age of the enlisted Airmen force is 29. Of the force, 38.47% are below the age of 26 and 14.58% of the officers force are below 26, versus 44.54% of enlisted Airmen forces (AFPC, 2008). Regrettably, it is apparent that the US Air Force demographic characteristics, in conjunction with the NHTSA's Traffic Safety Facts, indicate susceptibility and vulnerability to fatal MVCs (Bridget, 2001: 6).

Therefore, MVCs are not only a current problem for the US Air Force but also a future somber threat to its military personnel with enormous and varied woeful outcomes for them, their families, friends, and American taxpayers.

This thesis intends to use the AFSC data of MVCs in which US Air Force military personnel are involved when off duty and off base and apply Categorical

Data Analysis and Analysis of Variance (ANOVA) to address the following policy objectives respectively:

1. Identification of risk factors that are related to MVCs and influence the severity of injuries.

2. Identification of factors which are associated with alcohol consumption before driving and the factors affecting the number of lost workdays resulting from MVCs and influencing the total MVC direct costs.

Purpose and Rationale

The primary purposes of this thesis are to reinforce the published literature that identifies, quantifies and explores the MVC risks to US Air Force military personnel and improve the data analysis of MVCs to obtain more effective understanding that can assist US Air Force policy makers in making better decisions and applying more efficient intervention programs specifically tailored to various groups of Air Force military personnel.

In particular, this research attempts to deal with the following research questions:

1. Whether the factors of gender, age and rank of US Air Force military personnel affect their risk of MVCs and subsequent type of injury.

2. Whether the time of day influences the risk of MVCs and type of injury on US Air Force military personnel.

3. Whether the type of vehicle (motorized four-wheeled (4W), or two-wheeled (2W)) impacts the risk of MVCs and injury severity on US Air Force military personnel.

4. Whether the presence of alcohol is associated with the risk of involvement in MVCs.

5. Whether the seatbelt usage by US Air Force military personnel is associated with injury severity in the event of a MVC.

6. Whether the gender, age or rank of US Air Force military personnel is associated with the seatbelt usage when a MVC occurred.

7. What factors are related to alcohol consumption for those MVCs for which a toxicological (TOX) test was conducted?

8. What factors influence the number of lost workdays which affect the US Air Force's direct costs resulting from the MVCs in which its military personnel were involved?

Research Focus

This research focuses on MVC data collected by the US AFSC from F.Y. 1988 through F.Y. 2007 and contains data concerning MVCs in which US Air Force military personnel were involved when they were off duty and off base. This thesis is henceforth referring to military personnel when they are off duty and off base when this study uses the term, "military personnel".

Assumptions/Limitations

Based on the above research focus statement, the following assumptions were made to normalize the AFSC data and limitations identified before applying the methodology:

1. The initial data includes MVC events from F.Y. 1988 to F.Y. 2008 with the exact final date being the 19th of April 2008. Due to the large number of observations and because it is believed that having entire Fiscal Years would be more efficient for this study analysis, the seven months of F.Y. 2008 have been excluded. Therefore, the methodology was applied to the MVC observations reported from F.Y. 1988 through F.Y. 2007.

2. Since the study focuses only on US Air Force military personnel, it excludes the observations of MVCs in which military personnel of other military services have been involved.

3. Because most MVCs of US Air Force military personnel occur off duty and off base, on base and on duty MVCs were excluded.

4. The “Other Activities” besides “Operating Motor Vehicle” and “Passenger In/On Motor Vehicle” were also eliminated because the “Other Activities” were beyond the scope of this research effort.

5. The sixty one cadet victims and the one PMV mishap related to the rank of Brigadier General were kept out due to the lack of the population data of these USAF members.

6. Lastly, private boat or plane crashes were also excluded.

Therefore, the final number of PMV mishaps used for this study in which US Air Force military personnel had been involved as drivers or passengers from F.Y. 1988 through F.Y. 2007, when off duty and off base, is 12,403 which resulted in 13,788 traffic crash victims, rather than the 17,982 victims observed in the original AFSC data.

Preview

This chapter identifies the policy problem and purposes of this thesis, states its policy objectives, defines the research questions, and the assumptions/limitations that were made in order to normalize the AFSC data. Chapter II encloses a synopsis of the current literature review and knowledge about MVCs. The main goal of Chapter II is to understand the factors that cause MVCs, the MVCs’ consequences and the meaning of the intervention programs. A discussion of the methodology applied to analyze the data and answer the research questions is depicted in Chapter III. The outcomes of the Chapter III analysis are presented in Chapter IV, and finally, Chapter V outlines the conclusions of this study and recommendations for further research.

II. Literature Review

Motor Vehicle Crashes

Motor Vehicle Crashes (MVCs) are responsible for a significant number of fatalities and injuries. The "World Health Statistics 2008" report published by the World Health Organization (WHO) on 20 May 2008, foresees that injuries caused by MVCs will be one of the most rapidly growing public health concerns over the next 25 years. Fatalities due to MVCs are expected to rise from 1.3 million in 2004 to 2.4 million by the year 2030 and increase from the 9th cause of death in 2004 to the 5th cause in 2030 (WHO, 2008: 29-30). Figure 3 shows that there are regional and national differences in the distribution of road user mortality (WHO, 2004: 42).

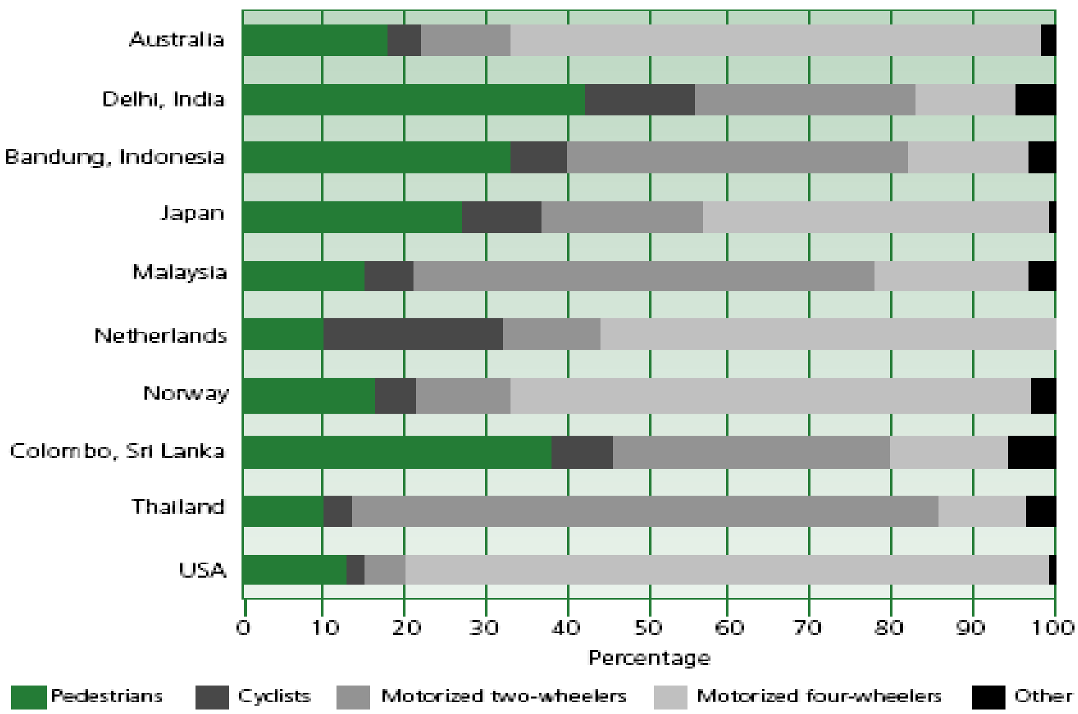

Figure 3. Road Users Killed in Various Modes of Transport as a Proportion of all Road Traffic Deaths
(Reproduced from WHO, 2004: 42 with the permission of the publisher)

The Air Force Safety Center (AFSC) data are consistent with the above findings, especially with those relating to the United States (US) population. 74.91% of MVC fatalities involved US Air Force military personnel either as drivers or passengers in/on motorized four wheelers during the road crash whereas only 25.09% of these involved motorized two wheelers.

MVCs are one of the most sobering national issues for the US. In a normal month, more Americans die due to the MVCs than were killed by the terrorist attack on 11th September 2001 in New York and Washington (Evans, 2003: 1384). According to the "Traffic Safety Facts Annual Reports" issued by the National Highway Traffic Safety Administration (NHTSA), from Fiscal Year (F.Y.) 1997 to F.Y. 2006, the US had on average, 6.3 million MVCs per year, 42,300 deaths and 2.9 million injuries per year. Figure 4 depicts the number of traffic fatalities in 2006 within the US by state and the percentage change from 2005.

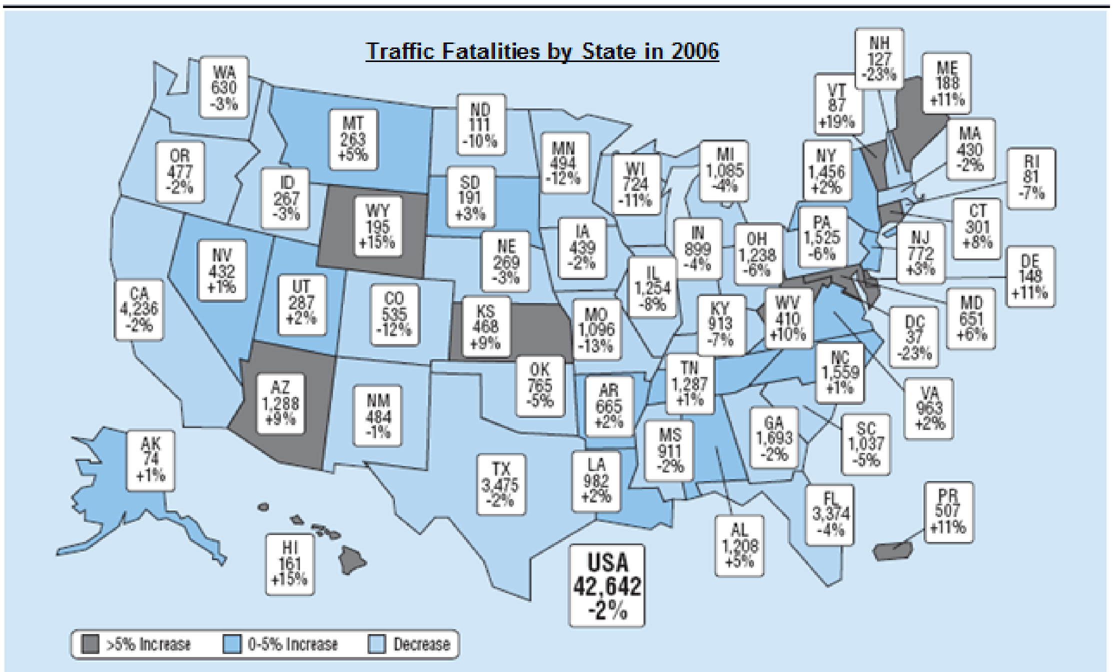

Figure 4. 2006 Traffic Fatalities by State and Percent Change from 2005 (NHTSA, 2007; 810-816: 1)

The US Air Force is one of many organizations in which MVCs have left personnel killed or permanently either partially or totally disabled. Furthermore, MVCs have had a financial impact upon the Air Force as well as on taxpayers. Although the US Air Force has made great efforts to reduce the number of MVCs in which its personnel are involved, the related lost workdays and costs reveal the gravity of the situation. Based on AFSC data over the last twenty years (F.Y. 1988 to F.Y. 2007), the Air Force has reported 12,403 Private Motor Vehicle (PMV) mishaps that have left 1,104 people dead, 242 people completely or partially disabled and 12,088 people with various types of injuries. Figure 5 provides a graphical representation of the PMV mishap rate per 100,000 US Air Force military personnel from F.Y. 1988 through F.Y. 2007.

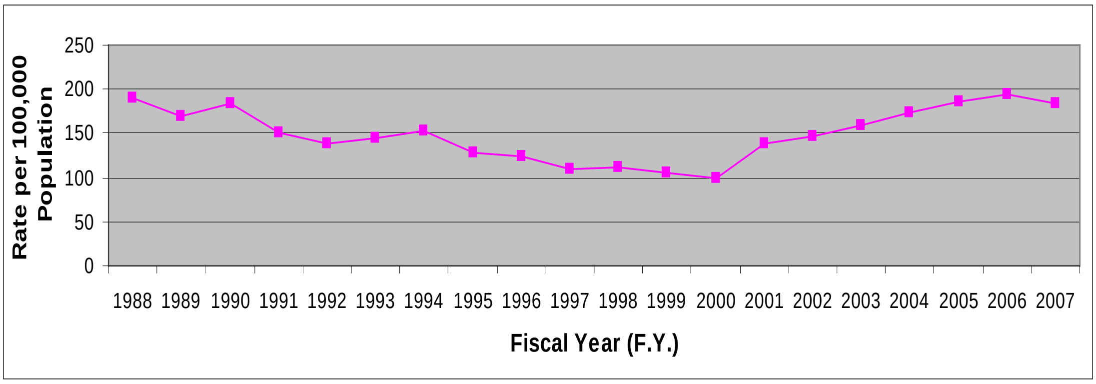

Figure 5. Rate of the PMV Mishaps per 100,000 US Air Force Military Personnel by F.Y.

Figure 6 depicts the rates of dead and Permanent Totally or Partially Disabled (PT or P Dis) victims per 100,000 US Air Force military personnel from F.Y. 1988 through F.Y. 2007.

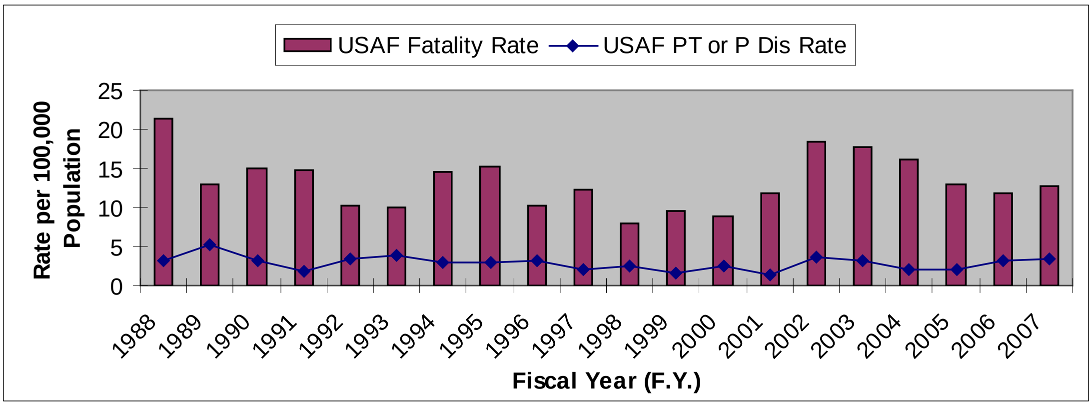

Figure 6. Fatalities and Permanent Total or Partial Disabilities Rates per 100,000 US Air Force Military Personnel by F.Y.

Finally, figure 7 presents the graphical representation of the lost workdays' rate per 100,000 US Air Force military personnel from F.Y. 1988 to F.Y. 2007, which has been caused by MVCs, without taking into account the number of lost workdays which have been caused by the fatal and permanent total or partially disabled cases. This thesis will discuss thoroughly the issue of the lost workdays' estimation in fatal and permanent total or partially disabled cases in Chapter III.

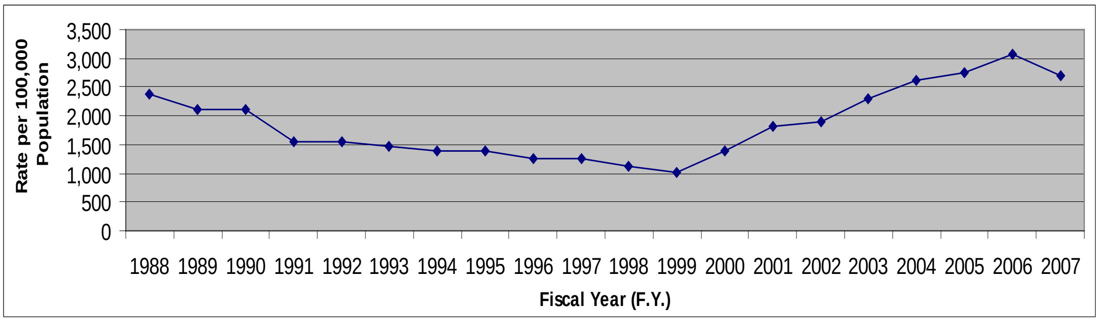

Figure 7. Rate of Lost Workdays per 100,000 US Air Force Military Personnel by F.Y.

Given the impacts of MVCs to the US Air Force this thesis will attempt to improve the data analysis of MVCs suffered by Air Force personnel when off duty and off base, to enable effective outcomes in reducing the rate and impact of MVCs. The objectives of this study are to identify risk factors that are related to MVCs, influence the severity of injuries, are associated with the alcohol consumption before driving and affect the number of lost workdays.

Definition.

Motor Vehicle Crash (MVC):

“an event that produces injury and/or property damage, involves a motor vehicle in transport, and occurs on a traffic way or while the vehicle is still in motion after running off the traffic way.”
(NHTSA, 2007; 810-818: 197)

This thesis uses the term “crash” instead of “accident” for one basic reason. Following Evans’s explanation in his book entitled “Traffic Safety and the Driver” the term “accident” is inappropriate for technical use. According to Evans, the term “accident” expresses a feeling that fate is responsible for the road traffic events (Evans, 1991: 8). This thesis submits that MVCs’ injuries and fatalities are not due to fate but rather that they are predictable and therefore preventable.

According to the WHO:

Road traffic fatality: “a death occurring within 30 days of the road traffic crash.”

Road traffic injuries: “fatal or non-fatal injuries incurred as a result of a road traffic crash.”

Road user: “a person using any part of the road system as a non-motorized or motorized transport user.”
(WHO, 2004: 201).

Source

This thesis intends to use many published resources regarding MVCs and traffic safety issues, but two agencies in particular will be the primary sources of information. This study will incorporate the data generated by these organizations’ in order to obtain statistical and other information about the MVCs that have occurred in the US or worldwide.

The National Highway Traffic Safety Administration (NHTSA).

NHTSA is the primary agency that investigates and analyzes the MVCs which occur within the US. NHTSA is an agency of the Executive Branch of the US Government, part of the Department of Transportation (DOT). Its mission as described at its official website is to:

> "Save lives, prevent injuries and reduce economic costs due to road traffic crashes, through education, research, safety standards and enforcement activity."

Some of the NHTSA's responsibilities and activities are:

- writing and enforcing safety, theft-resistance, and fuel economy standards for motor vehicles
- licensing vehicle manufacturers and importers
- allowing or blocking the import of vehicles and safety-regulated vehicle parts
- developing anthropomorphic dummies in safety testing, as well as the test protocols themselves
- providing vehicle insurance cost information

(Wikipedia, NHTSA; 2008).

In addition, NHTSA conducts or sponsors studies with the research goal of determining the causes of MVCs as well as to develop more effective and efficient means to improve safety (GAO, 03-436: 5).

NHTSA's major activity is the creation and maintenance of the data files maintained by the National Center for Statistics and Analysis. In particular, NHTSA has three principal databases which provide information about road crashes: the Fatality Analysis Reporting System (FARS), the Crashworthiness Data System (CDS), and the General Estimates System (GES) (NHTSA, Official Website; 2008).

The FARS contains information derived by the states on all MVCs that result in the death of a road user within 30 days of the incident. This data system was established, planned, and developed by the National Center for Statistics and Analysis (NCSA) to help and support traffic safety agencies to recognize traffic safety problems and assess both motor vehicle and highway safety standards and initiatives. FARS is one of the two major sources of data used at the NCSA (NHTSA/FARS, Official Website; 2008).

NHTSA's CDS contains detailed data on a random sample of minor, fatal crashes. Research teams located at Primary Sampling Units (PSU's) across the country study about 5,000 crashes a year involving passenger cars, light trucks, vans, and utility vehicles. Trained crash investigators obtain data from crash sites, studying evidence such as skid marks, fluid spills, broken glass, and bent guard rails.

Moreover, they locate the vehicles involved, photograph them, measure the crash damage, and identify interior locations that were struck by the occupants. These researchers follow up on their on-site investigations by interviewing crash victims and reviewing medical records to determine the nature and severity of injuries. Interviews with people in the crash are conducted with discretion and confidentiality (NHTSA/CDS, Official Website; 2008).

NHTSA's GES Data come from a nationally representative sample of police-reported motor vehicle crashes of all types, from minor crashes to those resulting in fatalities. The system aims to identify traffic safety problem areas, provide a basis for regulatory and consumer initiatives, and form the basis for cost and benefit analyses of traffic safety initiatives.

Likewise, the information is employed to estimate how many motor vehicle crashes of different kinds take place and what happens when they occur. Although sources suggest that about half the motor vehicle crashes in the country are not reported to the police, the majority of these unreported crashes involve only minor property damage and no significant personal injury (NHTSA/GES, Official Website; 2008).

The World Health Organization.

The WHO is the directing and coordinating authority for health within the United Nations system. It is responsible for providing leadership on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support to countries and monitoring and assessing health trends (WHO, Official Website; 2008).

The organization was established in 1948 as a specialized agency of the United Nations serving as the directing and coordinating authority for international health matters and public health. The WHO attempts through its publications to support national health strategies and address the most pressing public health concerns of populations around the world. To respond to the needs of Member States at all levels of development, the WHO publishes practical manuals, handbooks and training material for specific categories of health workers, internationally applicable guidelines and standards, reviews and analyses of health policies, programs and research and state-of-the-art reports that offer technical advice and recommendations for decision-makers (WHO, Official Website; 2008)

Road Traffic Risks & Factors that Cause MVCs

In traffic safety studies and research, it is worthwhile to identify the factors that increase the risk of MVC injury and fatality. This thesis will attempt to describe and explain this public health problem as other studies do and to identify the risk factors that cause MVCs and influence the injury severity on the US Air Force military personnel when off duty and off base. It is therefore important to point out that the understanding the meaning of risk is vital to this study. Before describing and analyzing the factors that contribute to a MVC event, it is necessary to attempt to clarify the meaning and the dimensions of the risk in road traffic.

In accordance with a WHO report published in 2004, there are four basic elements of road traffic risk. The first is the level of exposure to the road traffic environment, in terms of the amount of movement or travel that someone decides to make during his/her life. Additionally, in order to denote the remaining elements of the road traffic risk, the use of statistic terminology is needed. The conditional probability is the main characteristic of the three remaining road traffic risks. Hence, the second risk element is the probability of the crash given a specific level of exposure. The probability of injury, given the event of crash, is the third road traffic risk, and the fourth risk is the probability of the outcome and the severity of injury, given that the event of injury occurs (WHO, 2004: 71).

Exposure to Road Traffic Risk.

Since much of the world's population has to be a road user in everyday life in order to travel to work, school or vacation, visit friends, go shopping or generally enjoy themselves and relax, many people put themselves at a high risk of being involved in a MVC. The less someone exposes him/herself to the road traffic environment, the less probability there exists of being involved in a MVC.

The NHTSA carried out a study which examined the trend and pattern of highway traffic MVC fatality by month, day, and day of week for the period 1975-2002 (NHTSA, 2005; 809-855). The study revealed that the number of motor vehicle fatalities in the US was especially high during the holidays: New Year's, Memorial

Day, the 4th of July, Labor Day, Thanksgiving, and Christmas (NHTSA, 2005; 809-855: 16).

What is more, NHTSA indicates that July 4th and 3rd and December 23rd and 24th were the four days with the highest crash fatalities from 1975 to 2002 (NHTSA, 2005; 809-855: 9 & 19). These analyses also showed that the MVCs' fatality rates increased during weekends (NHTSA, 2005; 809-855: 17). Furthermore, January 1 and October 31 (Halloween) were the two days with the most pedestrian fatalities (NHTSA, 2005; 809-855: 19). Consistent with the above results, one can conclude that MVC rates escalate throughout the weekends or holiday periods due to the increased amount of movement or travel during these periods.

Risk of MVC Involvement.

Given the risk exposure discussed above, the probability of the MVC event depends basically on a series of factors that this thesis aims to thoroughly outline. Generally, factors such as driver behaviors and characteristics, and roadway or vehicle conditions significantly influence the risk of involvement in MVCs (WHO, 2004: 71 & GAO, 03-436: 6).

Risk of Injury.

The WHO reports that the factors that are associated with a high risk of MVC injury are the vehicle's crash protection system, the quality of roadside protection, the correct use vs. non use or misuse of the occupant protection systems and accessories, speeding in excess of the official speed limits and the consumption of alcohol. (WHO, 2004: 88).

Risk of Injury Outcome.

Many studies have concluded that a large number of people have died as a result of MVC before reaching the hospital. The WHO states that 50% of deaths related to MVCs occurred within a few minutes of the collision but before coming to a hospital (WHO, 2004: 93). Table 1 shows the proportion of MVCs' fatalities by the pre-hospital, emergency room and hospital ward phases in three different cities.

Table 1. Proportion of MVC Fatalities by Pre-Hospital and Hospital Phases (Reproduced from WHO, 2004: 93 with the permission of the publisher)

Setting	Kumasi, Ghana (%)	Monterrey, Mexico (%)	Seattle, USA (%)
Pre-hospital	81	72	59
Emergency room	5	21	18
Hospital ward	14	7	23

The WHO also supports the presumption that the likelihood of dying increased as the socioeconomic level of the MVC's victim decreased (WHO, 2004: 93).

The time between a MVC event and death or serious injury is extremely crucial and varies among patients and countries. Factors that can influence the risk of injury outcome, according to the WHO report are:

- the availability of first aid treatment and timely arrival of emergency medical services at the crash site
- the quality of medical treatment provided by the emergency services before arrival at hospital
- the quality of the hospital's facilities and services
- rehabilitation services and psychosocial support.

(WHO, 2004: 93).

Factors that Cause MVCs

The factors that cause MVCs are well known and documented. However, a MVC is a complex event and rarely can a single cause of such an incident be found.

One of the most widely known studies about the identification of the factors that cause road crashes is the "Tri–Level Study of the Causes of Traffic Accidents" conducted in the 1970s by the Indiana University at Bloomington Institute for

Research in Public Safety. The study results revealed that MVCs were brought about by drivers (human factors), environmental factors, and vehicle factors (GAO, 03-436: 4-5).

As presented in figure 8, the “Tri-Level Study” deduced that almost 70% of crashes were due to human factors, while about 21% and 9% were environmental and vehicle factors respectively (GAO, 03-436: 5).

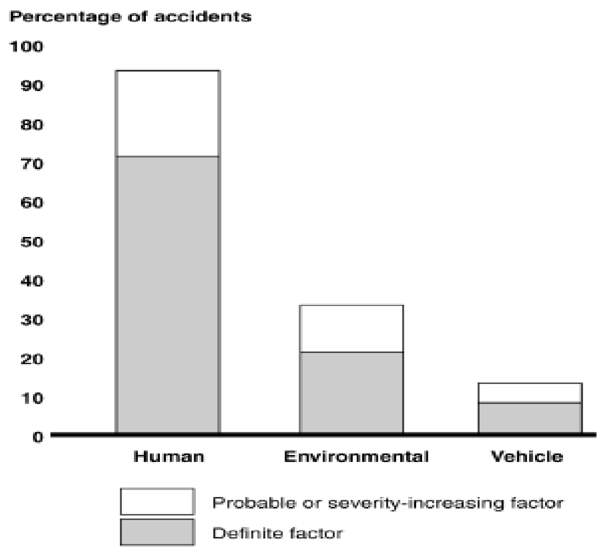

Figure 8. Tri-Level Study Results about the Factors that Cause MVCs (GAO, 03-436: 5)

Likewise, Rumar, based on the outcomes of the Sabey & Staughton study in 1975 and the Treat study in 1980, concluded that the road user (human factor) is the dominant factor that causes MVCs (Rumar, 1985: 156). Figure 9 illustrates these findings.

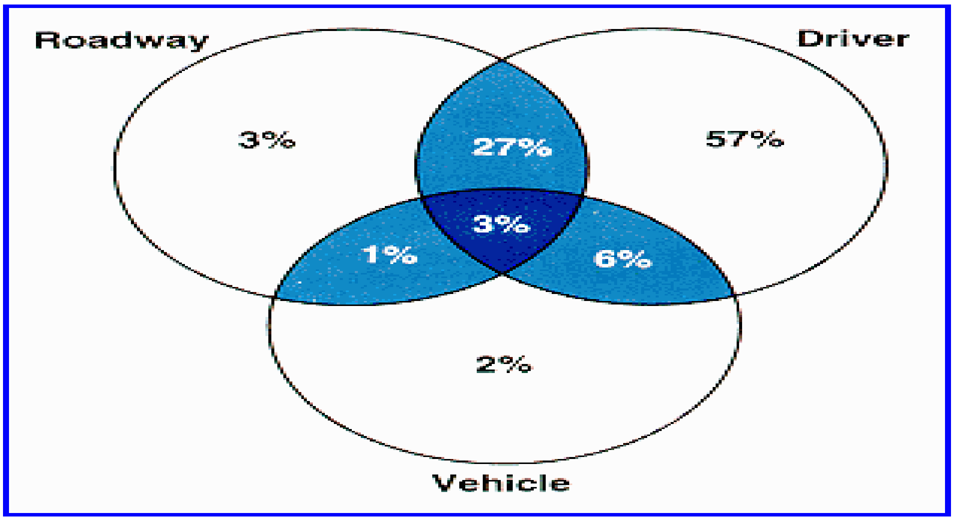

Figure 9. Venn Diagram Showing the Causes by Percentage, of Road Crashes Using British and American Crash Reports (Rumar, 1985: 155; Lum and Reagan, 1995)

According to the above Venn Diagram, 57% of MVCs were due to human (driver) factors, 27% were a combination of roadway and driver factors, 6% were combined human and vehicle factors, 3% of MVCs were due to roadway factors (roadway design, roadway hazards and roadway conditions), 1% to jointed roadway and vehicle factors, 2% of MVCs were due to vehicle factors (vehicle related failures and vehicle design including its size and safety) and 3% to combined human, roadway and vehicle factors (Rumar, 1985: 155).

This thesis, consistent with the above studies, supports that the main factors contributing to a MVC are the following:

1. Human Factors
2. Roadway Environment Factors and
3. Vehicle Factors

In accordance with the results of the above studies, but also consistent with the majority of the research and recorded expert opinion, the human factor - and more specifically the driver's behavior and characteristics - has been identified as the most crucial factor of the three. The driver factors are deemed to be the most prevalent in a

MVC occurrence, followed by the roadway environment and vehicle factors (GAO, 03-436: 7).

Although the above factors are able to contribute simultaneously to a MVC event, the purpose of this study is to analyze them independently as the other studies and research do.

Human Factors

Over the past years a significant number of studies, articles, reports by experts have deduced that driver characteristics, behaviors, decisions, physical condition and performance can affect the risk of the MVC occurrence and the level of injury severity. Human factors that are able to cause a MVC include the age, gender and the inexperience of the driver, speeding and other traffic violations, as well as driver impairment such as the effect of alcohol or other drug abuse. In addition, driver inattention or phenomena such as the non use of occupant protection systems, e.g. a safety belt or motorcycle helmet, and aberrant driver behavior can influence the risk of a MVC event.

Driver's Age, Gender and Inexperience.

According to the WHO, over 50% of the universal mortality due to MVC occurs among young adults aged between 15 and 44 years. Furthermore, the road traffic mortality rates are higher in males than females (WHO, 2004: 44). Figure 10 below reveals the importance of the variants, depicting the global road traffic deaths by age and gender group in 2002.

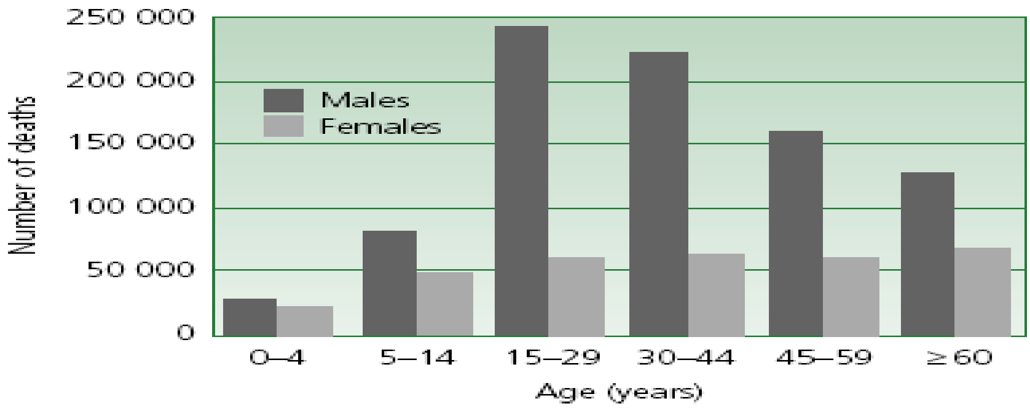

Figure 10. Universal Road Traffic Deaths by Age & Gender Group in 2002 (Reproduced from WHO, 2004: 45 with the permission of the publisher)

Based on NHTSA, in 2005, MVCs were the leading cause of death in the United States for every age 3 through 6 and 8 through 34 (NHTSA, 2008; 810-936: 1-2). Additionally, the GAO shows that the age of the driver to a large degree affects the probability of traffic crashes. More specifically, GAO found that younger and older drivers are involved in MVCs, especially with fatal injuries, more frequently than other age groups (GAO, 03-436: 17).

Perneger and Smith's population-based study claims that driving errors resulting in fatal two-car collisions do not occur at random, but affect excessively some groups of drivers. They conclude that there is a strong relationship between age and the probability of initiating an MVC. Compared with drivers aged 45-49 years, teenagers are three times, and those over 85 years 19 times, more likely to have initiated the MVC (Perneger and Smith,1991: 1138 & 1142).

Also interesting are the results of the Massie and others' study. This study, based on passenger-vehicle data in the US in F.Y. 1990, reveals that young men have a higher risk of fatal involvement than do women of comparative age, as is also demonstrated in figure 11 (Massie and others, 1995: 76).

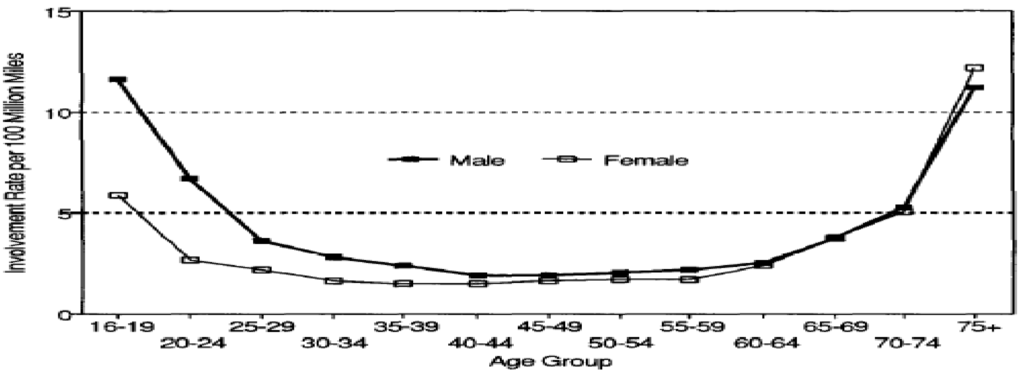

Figure 11. Fatal Involvement Rates per 100 Million Miles, Males vs. Females by Age Group (Reproduced from Massie & others, 1995: 77 with the permission of the publisher)

The above chart shows that the male and female curves are U-shaped, with the lowest fatal involvement rates are seen among 35-39, 45-49 and 55-59 age groups, while the highest rates are shown by the youngest and oldest age groups. The curves specify that age has a strong relationship to the differential risk of fatal involvement (Massie and others, 1995: 77).

Consistent with the above findings, the AFSC data indicates that gender and age of the US Air Force military personnel are relevant factors to the risk of fatal MVCs. Figure 12 presents the fatal involvement rates per 10,000 Vehicle Traveled Miles (VTM) for the USAF drivers by gender and age through F.Y. 1990 to F.Y. 2001 based on AFSC, Federal Highway Administration (FHWA) and National Household Travel Survey (NHTS) data (NHTS, 2009 & FHWA, 2009).

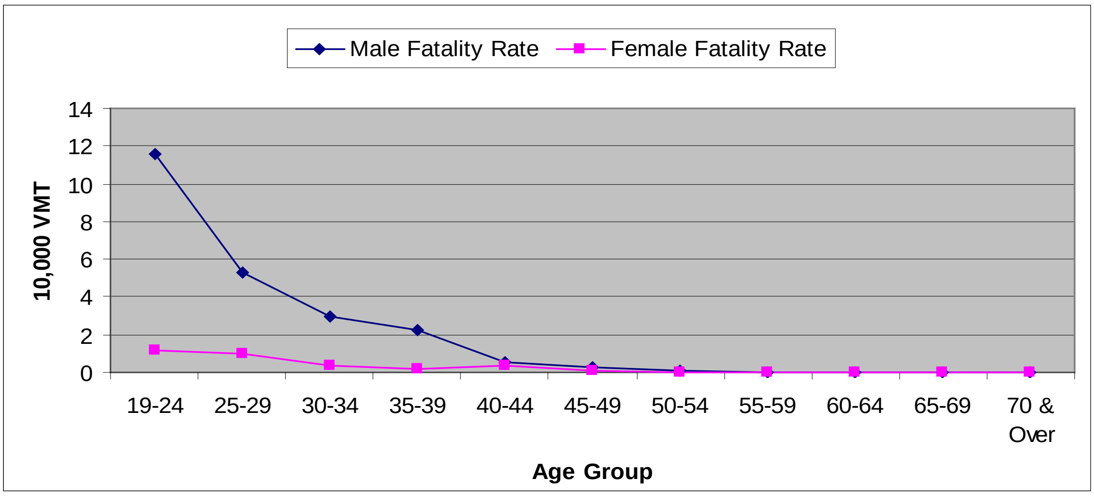

Figure 12. Fatal Involvement Rates per 10,000 VMT, USAF Male vs. Female Drivers by Age Group

Among US Air Force military personnel, the most prone to being involved in fatal MVCs are male drivers aged 19 to 24 years old. This study did not take into account the VTM of drivers under 19 years because these military members travel minimally due to their on base training commitment.

Furthermore, Massie and others concluded that young male drivers, compared with their female counterparts, are more prone to risky behavior. They tend to drive faster and closer to the vehicle in front of them when entering the traffic stream, run yellow lights or hastily turn left in front of oncoming traffic, not use seat belts or motorcycle helmets as often and drive after alcohol consumption, which may increase the risk of having more serious injuries in case of an MVC (Massie & others, 1995: 84).

Inexperience is another characteristic of drivers that can contribute to an MVC. Many studies, such as Zhang and others and Chipman and others have attributed inexperience to younger age groups (Zhang and others, 1998: 289 & 293) (Chipman and others, 1993: 211), and it seems reasonable to believe that young drivers do not have the same driving abilities and experience as older drivers.

However, the above arguments are difficult to prove since the experience of driving and the exposure to risk are often confounded (Jonah, 1986: 257).

Jonah, based on statistics from Canada and US traffic accidents in 1984, tried to explain that the relative effects of experience and age –related factors seem somewhat obscure. Definitely, an inexperienced driver is more prone to be involved in an MVC, but as Pelz and Schuman, in their attempt to separate experience and exposure, conclude:

"…length of driving experience-measured in this case from the time when the young man said he 'learned how to drive'-did not appear so important as age itself in accounting for infractions…"
(Jonah, 1986: 257)

It is obvious that young drivers, especially males, are at greater risk of being involved in a fatal MVC than older drivers and here is the paradox. Although young male drivers are considered to have better physical driving skills, and tend to have better reflexes than the other age groups of drivers, disproportionately more young male drivers are involved in MVCs (Rumar, 1985: 162-163).

One answer is that young male drivers are more prone to take risks while driving (Jonah: 1986: 265). The WHO specifies some of the factors that motivate young drivers to take risks while driving. These factors can include any or all of the following:

- Psychological characteristics, such as looking for excitement and over-confidence in their abilities
- Greater inclination to use/abuse alcohol than exists among older people
- Enhanced tendency to employ excessive driving speed than are older drivers.

(WHO, 2004: 79)

Likewise, as Jonah discusses, risk seems to attract young people more than it does other age groups in terms of expressing their passions, responding to peer pressure and the need for approval or feelings of power and control. Members of younger age groups tend to have the impression that they are invincible and that is the basic reason why young drivers have the propensity to take risks while driving and put their lives and others' lives at a higher risk of an MVC (Jonah, 1986: 268).

This thesis will consider in more detail in subsequent chapters whether the factors of gender, age and rank of US Air Force military personnel affect their risk of MVCs and subsequent severity of injury.

Speeding and Other Traffic Violations.

For decades, it has been well accepted that the speed of motor vehicles increases the risk of MVC occurrence and the likelihood of serious and fatal injuries. Currently, speed is a crucial factor due to the fact that modern vehicles have the mechanical capacity to reach high rates of speed and can easily accelerate within small distances (WHO, 2004: 76).

On the effects of speed on crashes and crash injury, WHO summarizes that:

"The greater the speed, the less time there is to prevent a collision. At the same time, the greater the speed, the more severe the consequences once a crash has occurred."
(WHO, 2004: 78)

Table 2 portrays the effects of speed limit changes in different countries

Table 2. Effects of Speed Limit Changes
(Reproduced from WHO, 2004: 127 with the permission of the publisher)

Date	Country	Type of road	Speed limit change	Effect of change on speed	Effect of change on number of fatalities
1985	Switzerland	Motorways	130 km/h to 120 km/h	5 km/h decrease in mean speeds	12% reduction
1985	Switzerland	Rural roads	100 km/h to 80 km/h	10 km/h decrease in mean speeds	6% reduction
1985	Denmark	Roads in built-up areas	60 km/h to 50 km/h	3-4 km/h decrease in mean speeds	24% reduction
1987	USA	Interstate highways	55 miles/h (88.5 km/h to 65 miles/h (104.6 km/h)	2-4 miles/h (3.2-6.4 km/h) increase in mean speeds	19-34% increase
1989	Sweden	Motorways	110 km/h to 90 km/h	14.4 km/h decrease in median speeds	21% reduction

Speeding decreases the driver's reaction capability in potential risky situations, such as hazards in the roadways or on curves, and lengthens both the distance and the time which are needed for the vehicle to stop (GAO, 03-436: 7). According to an NHTSA technical report, the speed decreases the vehicle's ability to decelerate, and reduces the ability of roadway protective equipment such as guardrails and barriers to stop the vehicle and protect vehicle occupants (NHTSA, 2005; 809-839: 33).

Additionally, in keeping with the same NHTSA report, 30% of all fatal crashes, resulting in approximately 1,000 fatalities, resulted from speeding-related MVCs every month in the US from 1983 to 2002. The report concludes that male drivers are more likely to be involved in speeding-related MVCs' fatalities than female counterparts among all age groups, although as the driver's age increases the gender gap concerning speeding decreases. It is also interesting to note that NHTSA detected during the above period that Western states had a higher percent of speeding-related fatalities than the Eastern half of the US (NHTSA, 2005; 809-839: 33).

The Mao and others study in 1997 tried to investigate the factors affecting the severity of MVC involving young drivers in Ontario. One of the results was that young drivers and especially male drivers were more likely to drive over the speed limit and were more vulnerable to being involved in MVCs (Mao and others, 1997: 184).

Furthermore, according to the following figure 13, it is obvious that younger male and female drivers are the most likely to be involved in a fatal MVC. Men also have more probability than women of any age category to be involved in a speed - related fatality (GAO, 03-436: 7-8).

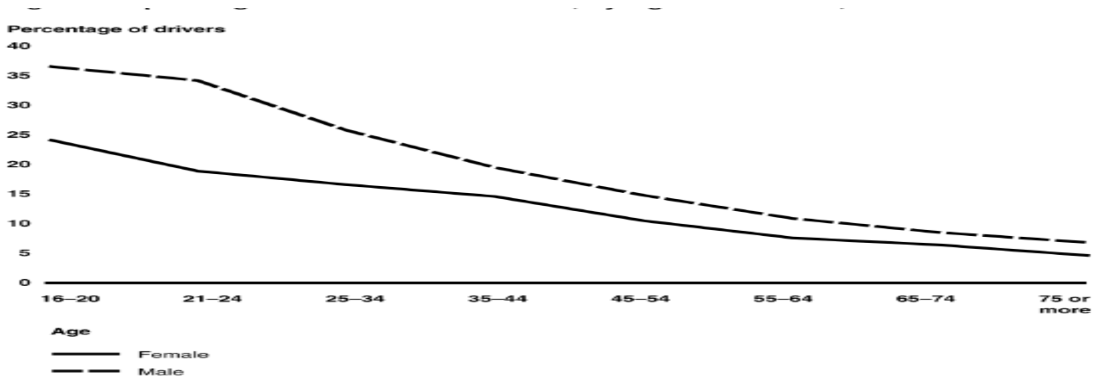

Figure 13. Speeding Driver in Fatal MVC in the US from 1997 to 2001, by Age and Gender (GAO, 03-436: 8)

Moreover, it is important to emphasize that the risk of having an MVC is increased both for vehicles travelling faster than the speed limits and for those travelling at speeds significantly under the speed limits (FHWA, 2008). The speed limits state the highest speed a driver is allowed to travel. However, each driver can choose the speed within the limit that is appropriate for him/her under specific circumstances related to the vehicle, roadway or environment factors.

Table 3 presents some of the factors that influence the drivers' speed decisions.

Table 3. Factors Affecting Drivers' Choice of Speed
(Reproduced from WHO, 2004: 76 with the permission of the publisher)

Road and Vehicle related	Traffic and environment related	Driver related
Road	**Traffic**	Age
Width	Density	Sex
Gradient	Composition	Reaction time
Alignment	Prevailing speed	Attitudes
Surroundings	**Environment**	Thrill-seeking
Layout	Weather	Risk acceptance
Markings	Surface condition	Hazard perception
Surface quality	Natural light	Alcohol level
Vehicle	Road lighting	Ownership of vehicle
Type	Sings	Circumstances of journey
Power/weight ratio	Speed limit	Occupancy of vehicle
Maximum speed	Enforcement	
Comfort		

Traffic law violations are also one of the factors that cause MVC. Those drivers who do not conform to the traffic laws increase the risk of being involved in an MVC. Some of the basic traffic control violations are driving without a valid driver's license, running red lights, failing to stop at stop signs or passing to the left without the correct procedure for this action being followed.

A GAO study (GAO, 03-436: 10) as well as other studies (Jonah, 1986: 259, 268, Perneger and Smith, 1991: 1141-1142, Massie and others, 1995: 84, Zhang and others, 1998: 292-293) found that young male drivers, road users who have committed prior driving violations, have invalid driver's licenses, and drive under the influence of alcohol, based on police reports, have the highest risk of being involved in an MVC.

It is also crucial to stress that the current lifestyle in our society has dangerously altered people's habits. The GAO study describes the results of the 1999 DaimlerChrysler Corporation survey provided to over 5,000 people concerning their behavior at red lights. The survey found that the majority of the "violators" who were running red lights claimed that they were in a rush and tried to save time (GAO, 03-436: 10).

This thesis will not be concerned with speeding as an influencing factor in the risk of MVCs and injury severity for the US Air Force military personnel due to the lack of this information in the AFSC data.

Driver Impairment.

Driver impairment includes excessive level (equal or above the statutory Blood Alcohol Concentration (BAC) Level) of alcohol or other drug abuse. Alcohol is an important factor in increasing the risk of an MVC event and crash severity. For this reason, this thesis will have a strong focus on this factor and its influence upon the risk of MVCs and injury severity on the US Air Force military personnel. According to the US Alcohol Policy Information System (APIS) website (APIS; 2008) and NHTSA (NHTSA, 2008; 810-920: 1), as of January 2007, in all 50 States, the District of Columbia, and Puerto Rico, it is illegal to drive or operate 4-wheeled or 2-wheeled vehicles with a blood alcohol concentration (BAC) of .08 grams per deciliter or above.

Figure 14 maps the rate of alcohol-impaired fatalities per 100 million Vehicle Miles of Travel (VMT) for each State in 2006.

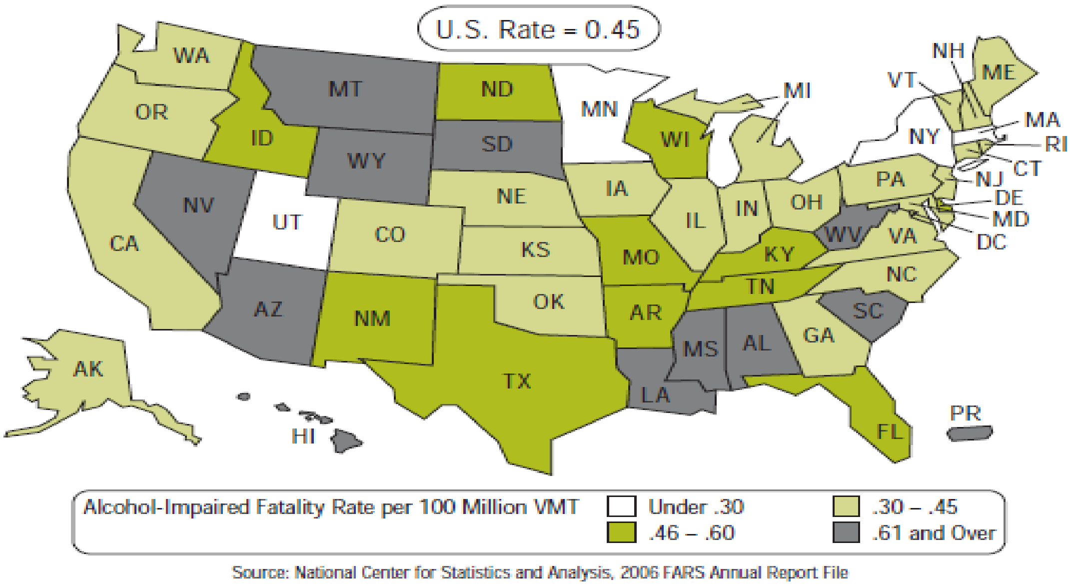

Figure 14. Alcohol Fatalities per 100 Million VMT by State in 2006 (NHTSA, 2008: 810-920: 1)

Table 4 describes the proportion of the alcohol-impaired driving fatalities that corresponds to each of the four categories of the alcohol-impaired fatality rate shown in the map in figure 14.

Table 4. Alcohol Fatalities & % of Total Alcohol Fatalities by Alcohol Fatality Rate Category in 2006 (NHTSA, 2008: 810-920: 2)

Alcohol-Impaired Fatality Rate	Number of States	Alcohol-Impaired Fatalities	Percent of U.S.
Under 0.30	4	739	6%
0.30 – 0.45	24 + D.C.	6,133	46%
0.46 – 0.60	11	4,129	31%
0.61 & Over	11	2,470	18%
U.S.	-	13,470	100%

More specifically, in 2006 the highest proportion of all alcohol-impaired fatalities was 46% with an alcohol-impaired fatality rate between 0.30 and 0.45, followed by 31% with rates between 0.46 and 0.60 (NHTSA, 2008: 810-920: 1-2).

In 1964, a case study conducted in the US known as “Grand Rapids” found that drivers under the influence of alcohol had a higher risk of being involved in

MVCs than did drivers who were sober (WHO, 2004: 80). The Compton RP's study, more recent than the "Grand Rapids", carried out in the US at Long Beach, California and Fort Lauderdale, Florida, reached results consistent with the "Grand Rapids" findings (WHO, 2004: 80).

Figure 15 depicts that the greater the BAC of the driver the higher the relative likelihood of that driver's being involved in an MVC becomes.

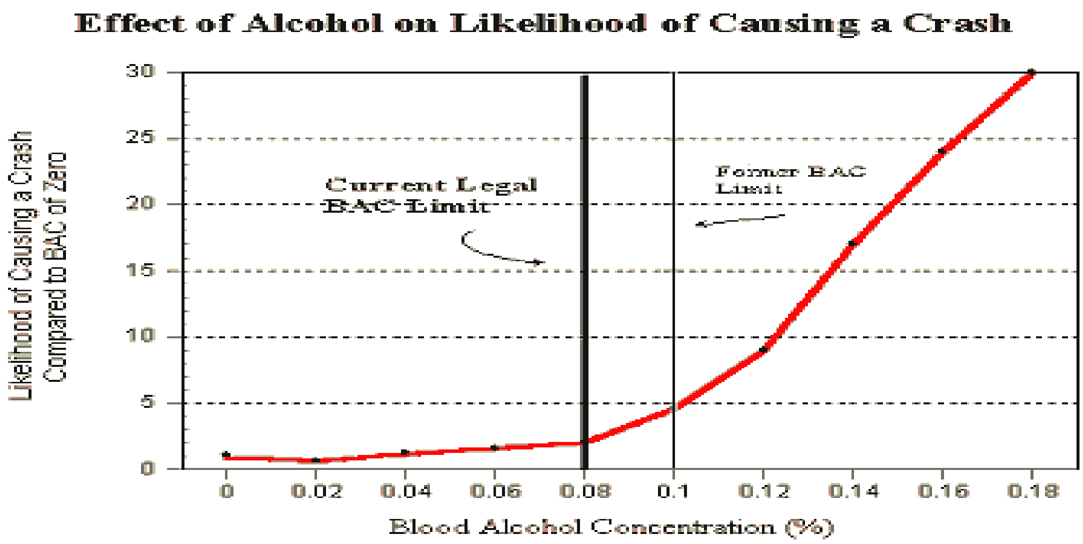

Figure 15. The Alcohol Effects on the Probability of MVC (Reproduced from the University of North Carolina, Highway Safety Research Center's Alcohol Studies with the permission of the publisher)

Additionally, the GAO supports the above conclusion (GAO, 03-436: 11-14). However, the GAO claims that young male drivers are the most vulnerable group to be involved in MVCs while the influence of alcohol (GAO, 03-436: 11-12). Figure 16 portrays the gravity of the situation among young drivers.

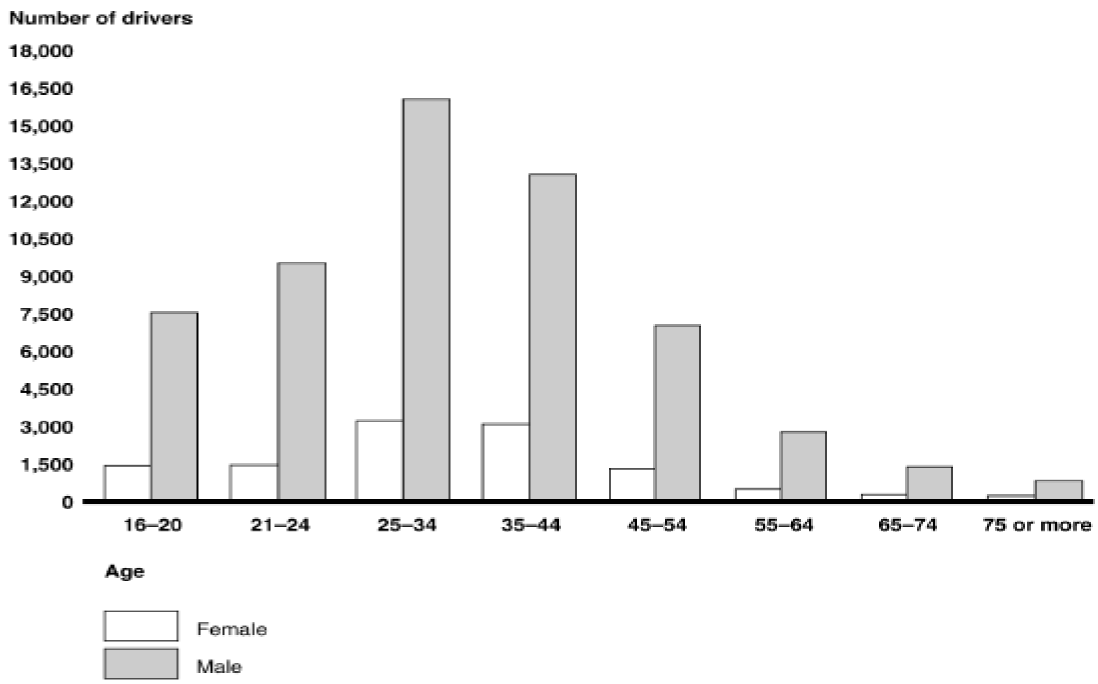

Figure 16. Drivers in Alcohol-Related Fatal Crashes in the US from 1997 to 2001, by Age and Gender (GAO, 03-436: 12)

The most recent study carried out by NHTSA is a statistical analysis of alcohol related driving trends in the US from 1982 to 2005 (NHTSA, 2008; 810-942). The conclusions of this analysis are consistent with the GAO report (GAO, 03-436: 11-14). The NHTSA found that the drivers drink less as they become older and therefore, are less likely to be involved in an alcohol- related MVC fatal crash or in one resulting in serious injury. Females were also found to be less inclined to combine alcohol with driving than are males (NHTSA, 2008; 810-942: 40).

Many other studies have reached the same conclusions. A cross-sectional analysis conducted in 1991 by Zlatoper in order to estimate a model of motor vehicle deaths in the US indicates that the alcohol consumption variable is directly related to motor vehicle fatality rates with an estimated coefficient of 2.646 at $\alpha = 0.05$ level of significance and high t-statistic equal to 3.27 (Zlatoper, 1991: 434-435). Likewise, Perneger and Smith characterize alcohol consumption as the strongest risk factor for MVC initiation for their study (Perneger and Smith, 1991: 1138).

Jonah, in his analysis of accident risk and risk taking behavior among young drivers gives an explanation of this elevated risk among young impaired drivers. Based on his findings young age groups drive impaired because they are more socially active, and they have more opportunities to drink than do older drivers, especially at night (Jonah, 1986: 260).

The consumption of drugs and their effect of increasing the risk of MVC events remain undetermined. The WHO claims that currently, there is no verification that the consumption of drugs is associated with significant MVC risk (WHO, 2004: 84). But, the WHO points out that there is evidence that drivers who take many psychoactive drugs, both medicinal and recreational, consume them in combination with alcohol. In that case, the consumption of the above type of drugs in conjunction with alcohol can be a crucial factor in contributing to a serious MVC (WHO, 2004: 84).

The GAO also concludes that the consumption of marijuana in combination with alcohol negatively influences driving ability and performance and increase the risk of being involved in an MVC with serious injuries (GAO, 03-436: 14). However, the GAO also presents another study which was carried out by Maastricht University, the Netherlands, which found that drivers were less able to perceive peripheral traffic when they were under the influence of low doses of either alcohol or marijuana (GAO, 03-436: 14). Finally, the Zhang and others study in Canada reveals a positive relationship between driving while impaired by either illicit drugs or prescription drugs and MVC occurrence with fatal injury, especially among elderly drivers (Zhang and others, 1998: 293).

This study will try to answer if the presence of alcohol influences the risk of involvement in MVCs for US Air Force military personnel. Furthermore, the study will examine which factors are associated with alcohol consumption before driving for those MVCs where the presence of alcohol was tested.

Driver Inattention.

"Driver inattention occurs when there is a delay in recognition of information needed to safely accomplish the driving task."
(GAO, 03-436: 14).

The GAO differentiates inattentiveness into two categories. The first is the distraction category, which includes visual distraction, auditory distraction, biomechanical distraction and cognitive distraction. The second category is the drowsiness or sleep category, which is associated with driver fatigue (GAO, 03-436: 14).

Figure 17 displays the results of the GAO's analysis of NHTSA's data. Based on this chart, of the 2.5 million drivers of passenger vehicles that were towed away from MVCs due to their inattentiveness, 52% were distracted, about 34.84% claimed that they were lost in thought, and 13.92% suffered sleepiness or drowsiness.

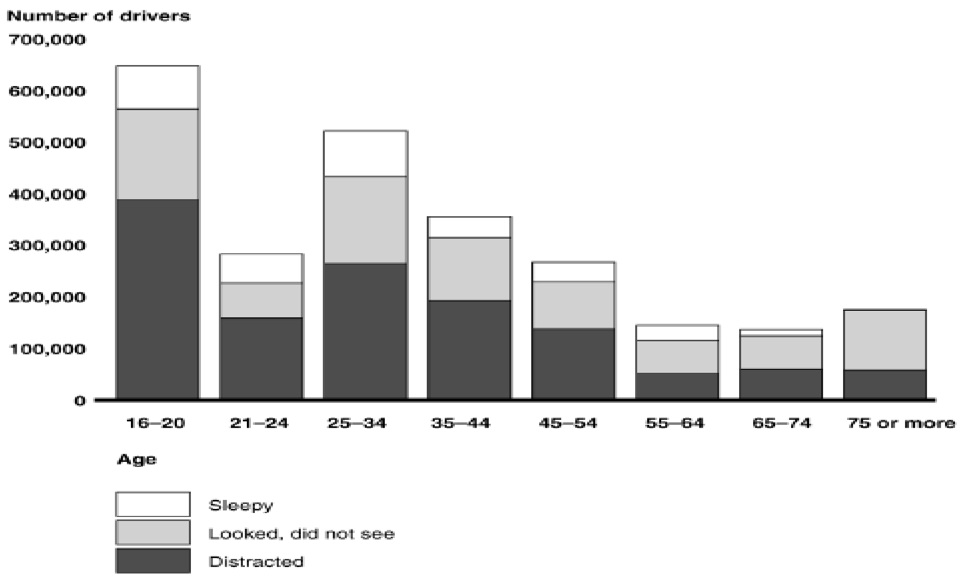

Figure 17. Inattentive Drivers Involved in MVCs by Age, 1997-2001 (GAO, 03-436: 15)

Moreover, the GAO study concludes that the drivers who are the most inattentive of age group are those drivers aged 16 to 20 (GAO, 03-436: 15).

It is interesting to point out that the basic reason for auditory distraction is the hand held mobile telephone. In the US these telephones have increased in numbers from 500,000 in 1985 to 120 million in 2001 (WHO, 2004: 81). The WHO claims that the risk of an MVC when the drivers make use of their cell phone is four times greater than for those who do not use them. Finally, recent studies have shown that the use of hands-free telephones is still able to distract drivers but the effects are less harmful than those of using hand held mobile telephones (WHO, 2004: 85).

Sleepiness and fatigue are crucial causes of a MVC event. According to the National Sleep Foundation's Sleep in America poll, 60% of Americans have driven while feeling sleepy and 37% admit to actually having fallen asleep at the wheel in the past year. However, the National Sleep Foundation claims that many people cannot tell if or when they are about to fall asleep. Therefore, when drivers feel sleepiness while driving, many of them believe that they can handle this by smoking, eating or drinking and listening to music but they put themselves and others at a high risk of MVC occurrence (National Sleep Foundation, 2008).

The WHO identifies three high risk groups who are vulnerable to drowsiness. The first group is young males, 16 to 29 years old. The second one is shift workers who have to work at night or irregular hours not in sync with the "Internal Circadian Biological Clock." According to the National Sleep Foundation, the human "Internal Circadian Biological Clock" programs the timing of periods of sleepiness and wakefulness throughout the day. The circadian rhythm dips and rises at different times of the day and depends on whether someone is a "morning person" or "evening person." Therefore, adults' strongest sleep drive generally occurs between 2:00-4:00

am and in the afternoon between 1:00-3:00 pm (National Sleep Foundation, 2008). Finally, the last high risk group is those people who suffer from untreated sleep apnea syndrome or narcolepsy (WHO, 2004: 85).

This research will not be addressing driver inattention as a factor affecting the risk of MVCs and injury severity for US Air Force military personnel due to the lack of this information in the AFSC data.

Occupant Protection System.

The three basic occupant protection systems are safety belts and airbags for four-wheeled vehicle users, and crash helmets for two-wheeled vehicle users. Almost all of the studies on traffic safety conclude that the failure of the driver and motorcycle rider to use seat belt or helmet respectively is a basic cause of serious MVC injuries. For the purposes of this study, air bags and crash helmets will be excluded from consideration as factors that influence the risk of MVCs and injury severity on the US Air Force military personnel due to the lack of this information in AFSC data.

In February 1996, NHTSA submitted a report to Congress on the benefits of safety belts and motorcycle helmets. The report results confirmed that safety belts are highly effective in preventing injuries and fatalities in MVCs, and that they minimize the severity of injuries when these do occur. NHTSA estimated that safety belts are 40 to 50% effective in preventing MVC fatal injury and 45 to 55 % effective in avoiding serious MVC injuries. In contrast, the same report finds that helmets are not able to defend the rider from most kinds of MVC injuries (NHTSA, 1996; 808-347: 32-33).

However, NHTSA believes that motorcycle helmets are 67% effective in avoiding brain injuries. More specifically, riders who wear a helmet were three times less likely to experience a head injury than were the riders who did not use helmets (NHTSA, 1996; 808-347: 33).

Table 5 depicts the benefits of seat belts in terms of their effectiveness in various types of MVCs.

Table 5. Benefits of Seatbelts in Terms of their Effectiveness in Various Types of MVCs
(Reproduced from WHO, 2004: 91 with the permission of the publisher)

Crash type	Proportion of all crashes (%)	Driver seat-belt effectiveness in different crash types (%)
Frontal	59	43
Struck side	14	27
Non-struck side	9	39
Rear	5	49
Roll-over	14	77

According to an NHTSA research note, the 2007 survey for seat belt usage in the US indicates that the use of this safety system is lower among 16 to 24 year olds than among other age groups and that females use the seat belt more than males (NHTSA, 2008; 810-932: 1). Furthermore, seat belt usage continues to be lower among the black population than among other communities. Finally, as measured by NHTSA's National Occupant Protection Use Survey (NOPUS), the use of seat belts nationwide was 82% in 2007, a small increase from the 2006 use rate of 81% (NHTSA, 2008; 810-932: 1).

The WHO finds that helmets decrease the number of MVCs' resultant fatal and serious injuries by between 20% and 45% (WHO, 2004: 90). According to NHTSA in 2005, 4,553 motorcyclists were killed and almost 87,000 were injured in MVCs in the US (NHTSA, 2006; 810-620: 1). NHTSA claims that motorcycle helmets are 37 percent effective at protecting from fatal injuries and save about 1,500 rider lives each year (NHTSA, 2007; 810-840: 5). Therefore, NHTSA estimates that helmets prevented 1,546 motorcyclist fatalities in 2005, and that 728 more would not have died if all motorcyclists were helmeted (NHTSA, 2006; 810-620: 1).

Finally, it is extremely important to stress that the helmet, which the motorcyclist is to wear for head protection must satisfy official safety standards. A study in California showed that riders, who wore either regular certified helmets or no helmets at all, sustained less frequent brain injuries than those who used non-standard helmets (WHO, 2004: 90).

The objective of driver air bags is to offer protection for seat belted or unbelted drivers and passengers in frontal MVCs (WHO, 2004:92). NHTSA found that air bags in conjunction with safety belts provide one of the most effective occupant protection systems currently available (NHTSA, 2006; 810-621: 5).

A recent NHTSA study showed a 14% fatality-decreasing effectiveness for air bags without use of safety belt and 11% when a safety belt was used in combination with air bags. It is, however, crucial to point out that air bags are an accessorial occupant protection system and are not designed to perform in all crashes. Additionally, NHTSA clarifies that some MVCs at lower speeds are able to cause injuries, but not the serious injuries that air bags are designed to avoid. Therefore, NHTSA advises that occupants of vehicles should always wear seat belts, even in vehicles with air bags (NHTSA, 2006; 810-621: 5).

NHTSA also warns that drivers of motor vehicles should be cautious with the seating placement for child passengers. For example, children in rear-facing child safety seats should not be placed in the front seat of vehicles equipped with passenger-side air bags. The impact of a deploying air bag striking a rear-facing child safety seat could result in injury to the child (NHTSA, 2006; 810-621: 5).

This thesis will address the question of whether seatbelt usage of US Air Force military personnel is associated with injury severity in the event of an MVC. In addition, this study will examine whether the gender, age or rank of the US Air Force personnel is related to seatbelt usage when an MVC occurred.

Driver Behavior.

It has been widely accepted and documented that driver behavior is the core of the MVC event (Kontogiannis and others, 2002; 381). Evans believes that the two crucial factors that influence the individual's risk in traffic are the individual's behavior and the behavior of other road users (Evans, 2003; 1385). The GAO claims that behavioral error is the major factor causing or contributing to the MVC (GAO, 03-436: 17).

Hans Monderman, a Dutch civil engineer and road safety expert, was one of those who maintained that driver behavior is the most significant factor that affects the risk of the MVCs (Times on Line, 2008). Moderman's most popular concept is the "Shared Space" model (Times on Line, 2008). The basic principle of this model is that the human interaction and eye contact are more beneficial means than traffic signs and rules in order to maintain an area's safety and reduce MVCs (Times on Line, 2008).

The "shared space" principles have applied in West Palm Beach, Florida. Road traffic signals and markings have been removed from local areas where pedestrians have closer contact with cars. The planners of the experiment have observed that the traffic has been slower, MVCs have decreased and trip times have been reduced (McNichol, 2008).

Another interesting approach to drivers' behaviors is Evans' view of this important issue. Evans believes that the crucial issue is the drivers' behaviors (how the drivers do drive) and not the drivers' performance (how the drivers can drive). He continues that:

"…people in general drive as they live. Involvement in traffic crashes is correlated with being emotionally unstable, unhappy, asocial, anti-social, impulsive, aggressive, and being under stress."
(Evans, 1991: 158).

However, this thesis asserts that more research is needed in the driver behavior area in order to provide a better understanding of what motivates and "encourages" the aberrant driver's behavior and errors. The psychological approach of driver behavior is beyond the scope of this thesis purpose.

Roadway Environment Factors

According to the study conducted in 1985 by K. Rumar, using British and American crash reports as a source of data, about 34% of serious MVCs appear to have been, at least in art, caused by factors associated with the roadway or its environment (Rumar, 1985: 155; Lum and Reagan, 1995). The GAO also supports that the roadway environment is one of the factors that are related to the risk of MVC events and is the second most prevalent cause contributing to MVCs (GAO, 03-436: 6-7). Moreover road networks are the core of the exposure to road traffic risk. If there were no road networks, there would be no MVCs.

In this study the meaning of roadway environment factors is in compliance with the above GAO report and covers the design of the roadway, the roadside hazards, and the roadway condition (GAO, 03-436: 20).

Roadway Design.

Roadway design basically includes the plan, construction and design of the medians, barriers, lanes and their width, shoulders, the curves and their slopes, access points or intersections (GAO, 03-436: 20). The road design is associated with the risk of an MVC occurrence. According to WHO there are four elements in the planning, design and maintenance of the road network that influence the road safety.

“These elements are: the safety awareness in the planning of new road networks, the incorporation of safety features in the design of new roads; the safety improvements to existing roads and the remedial action at high-risk crash sites. The absence of any of these elements is risk factors for crashes.”
(WHO, 2004: 87).

The Institute of Advanced Motorists (IAM) Motoring Trust is an independent road safety organization whose research in road traffic issues in Britain, from 2000 to 2005, showed that on average two – thirds of all road deaths per day in the country happen on rural roads (IAM’s Rural Road report, 2008). In addition, GAO reports that fatal MVCs occurred more often on rural roads than on urban roads (GAO, 03-436: 21). Apart from roadside hazards (trees or natural embankments adjacent to the roads) on rural roads, which this thesis is going to analyze below, the poor design of these roads is the basic reason that the risk of an MVC occurring on these roads is higher than on urban roads (GAO, 03-436: 21).

GAO claims that it is crucial for the roadway to be designed to provide drivers with the space and time that are needed for them to take the appropriate actions in order to remedy some possible driving mistakes, without collisions. Most two lane rural roads have curves with steep slopes, narrow lanes, no shoulders and many roadside hazards. All the above characteristics of rural roads increase the risk of MVC involvement (GAO, 03-436: 21-23).

Roadside Hazards.

WHO claims that collisions between vehicles that fail to follow the route of the road and solid roadside objects such as poles, trees and road signs are a basic road safety issue universally. Between 18% and 42% of fatal MVCs are due to roadside hazards in Australia and many European countries (WHO, 2004: 93). The IAM

Motoring Trust Report also concluded that almost 40% of MVC fatalities in Britain's rural roads resulted from vehicles leaving the road and colliding into roadside fixed objects, such as trees (Castle and others, 2008). The particular characteristic of these MVCs is the restricted visibility of the drivers as a result of the poor location of these objects (WHO, 2004: 93).

Unfortunately, the US is also one of the countries that suffer from these types of collisions. GAO reveals that 14,000 people are killed per year and about 1 million people are injured during the same period when their vehicles leave the road and impact roadside objects such as poles and trees. From 1997 to 2001, about 20% of total impacts with roadside hazards were posts or poles, 14% were ditches, 14% were trees and 11% were guardrails (GAO, 03-436: 24). The small distance from the edge of the road to roadside objects and the large number of trees next to the US rural roads are the major causes of increasing the risk of MVC events and the severity of injuries (GAO, 03-436: 24).

The responsible agent for roadway design in the US is the American Association of State Highway and Transportation Officials (AASHTO). AASHTO states that MVC injuries and fatalities due to roadside hazards are a crucial problem for the US because more than 40% of all fatal traffic crashes in 2003 involved vehicles running off the road (AASHTO Safety Plan, 2005). The AASHTO Strategic Highway Safety Plan published in 2005 states that one-third of all highway fatalities and two-thirds of all rural fatalities resulted from vehicles leaving the road and crashing into fixed objects, such as trees, embankments or utility poles.

In addition, the responsible agent of US roadway design reveals that trees are the most "murderous" roadside hazards of all fixed objects on rural roads, and declares that very little has been achieved towards addressing this problem on a national level. Moreover, it mentions that, based on NHTSA's traffic safety facts 2003, one of the leading roadside hazards in terms of highway deaths is the utility pole. AASHTO through its plan agrees that the cost, not only to remove the trees but also, to relocate poles is staggering. However, AASHTO asserts that an appropriately funded program would yield very cost-effective safety improvements, which would reduce this problem for many years.

Roadway Conditions.

Roadway conditions can affect the risk of an MVC event. There are two issues relating to the condition of the roads, the road surface situation and reduced visibility which can be influenced by either the lack of daylight or bad weather (GAO, 03-436: 24-26). According to the GAO report, if a road surface is either in bad condition with holes, ruts, paved edge drop-offs, and worn or slippery surfaces, the drivers' ability to control their cars is compromised and the probability of being involved in MVCs is increased (GAO, 03-436: 24-26).

Furthermore, in accordance with the WHO report a fundamental requirement for traffic safety of the road users is:

"To see and be seen"

In general, visual errors have a direct positive relationship with the cause of MVCs (WHO, 2004: 85-86). It is apparent that when drivers have reduced visibility they are not able to manage their cars and there is a greater possibility of an MVC. Events associated with weather or the presence or absence of artificial or natural lighting are the most frequent factors that cause reduced visibility to drivers (GAO, 03-436: 24-26).

A slippery road surface is one of the most dangerous conditions that a driver can encounter while driving. Rain, snow, sleet, and ice can create slippery roads. The problem with slippery roads is that the reduced friction between the roadway surface and the tires of the vehicle can lead to a wide variety of MVC events (GAO, 03-436: 25). The Mao and others research in Ontario shows that MVCs occur more frequently on wet roads and during snowy weather (Mao and others, 1997: 187). Additionally, in accordance with the same research, sleet, apart from some other factors that this thesis will analyze next, was found to increase the risk of fatal MVCs (Mao and others, 1997: 187).

Inadequate visibility can occur either during the nighttime period or during specific weather conditions such as fog, rain, snow or strong winds (GAO, 03-436: 25-26 & Mao and others, 1997; 187). The WHO report indentifies three types of crashes that can occur due to drivers' reduced visibility:

"1. a moving vehicle running into the rear or side of a slowly moving or stationary vehicle located ahead on the roadway, at night-time
2. angled collisions or head-on collisions in the daytime;
3. rear-end collisions in fog, in daytime and at night."
(WHO, 2004: 86).

According to Rumar the accident rate at night is 2-3 times higher than during the daytime period (Rumar, 1985: 160). The above finding is consistent with the NHTSA research note in which NHTSA makes a contrast between passenger vehicle occupant fatalities occurring during the day and those occurring at night. The results are dramatic. The MVC fatality rate at night seems to be three times higher than the daytime rate. NHTSA offers many other reasons apart from inadequate visibility for this higher fatality rate for which the night is blamed (NHTSA, 2007; 810-637: 1, 4).

The main reason for higher fatality rates at night in comparison with daytime is that drivers tend to take more risks during nighttime travel. NHTSA found that the risks which drivers and passengers had taken were, lower seat belt use, high rate of alcohol involvement, and high speed above of the statutory speed limits (NHTSA, 2007; 810-637: 4).

Some of the NHTSA findings are provided below:

- Of the total unrestrained driver and passenger deaths in 2005, 64% of them occurred during the nighttime and 46% during the daytime MVCs
- The alcohol involvement in vehicle occupant fatalities was 3.3 times higher during nighttime MVCs than during daytime MVCs
- A higher proportion of drivers and passengers involved in fatal MVCs were killed in speeding-related MVCs at nighttime (NHTSA, 2007; 810-637: 4).

An exploratory study in Australia investigated the environmental factors associated with crash-related mortality and injury among taxi drivers in New South Wales. The study observed 7,923 taxi drivers who were involved in MVCs, almost 10% of whom were killed or injured. Findings show gender, and one environmental factor to be significantly related with an increased risk of MVC fatality and injury among taxi drivers. The risk rate of MVC fatality and morbidity is increased by 60% for those who work night shifts (Lam, 2004; 36: 905).

The design of the roadway, roadside hazards, inadequate visibility and road surface conditions are factors directly associated with the risk of MVC occurrence and the severity of the injury. Nevertheless, for the purposes of this study, roadway environment factors other than the “time of the day” and especially the reduced visibility during the night hours will be excluded from consideration as factors that influence the risk of MVCs and the injury severity which may be inflicted on crash victims among the US Air Force military personnel, as the AFSC data do not provide this information. However, as outlined above, the role of drivers and their behaviors continue to fill a dominant role in the level of risk more than the roadway and its environment.

Vehicle Factors

The contribution of vehicle factors to the event of serious MVCs is about 2% and 10% in combination with the roadway environment and driver factors (Rumar, 1985: 155; Lum and Reagan, 1995). The WHO claims that in general there is no evidence that periodic motor vehicle inspections reduce the incidence of MVCs events (WHO, 2004: 88).

However, the quality of vehicle design, including its size (Evans, 1991), the periodic checks of vehicle operating condition and its maintenance influence safety and driver control in dangerous situations and affect the ability to avoid crashes (Air Force Institute of Technology (AFIT)/Safety Office (SO), 2008). Many studies and experts support that vehicle factors contribute less to MVCs than do either driver or roadway environment factors (GAO, 03-436: 26). As both the GAO report and Evans's book, titled "Traffic Safety and the Driver," contend, this thesis asserts that the two main issues associated with vehicle factors are vehicle related failures and vehicle design including its size and safety characteristics (GAO, 03-436: 26-32 & Evans, 1991: 64-95).

Vehicle Related Failures.

Vehicle failure can influence the risk of a MVC occurrence by either some kind of equipment- related failures or maintenance related failures (GAO, 03-436: 26). The main responsibility for equipment related failures lies with the manufacturer of the vehicle while the owner of the vehicle is responsible for maintenance related failures. In the US equipment related failures can be detected by the manufacturer or by NHTSA, and can result in a recall of the product if it is necessary for public safety (GAO, 03-436: 27).

The owner or operator of the vehicle is accountable for maintenance related failures. For example, the drivers have to check the mechanical and electrical systems of their car periodically and they should rectify any problem they encounter during their inspection.

GAO analysis found that 778,000 MVCs of the total which occurred from 1997 to 2001 in the USA were associated with vehicle related failures such as defects on brake systems, and tires without tread depths or improperly inflated (under inflated) (GAO, 03-436: 27). It is well documented that smooth tires can result in a blowout at high speeds or loss of control of the vehicle on wet road surfaces. Moreover, tires low on air will have weaker grip on the road and can have excessive sidewall flexing that increases tire wear and may possibly lead to a blowout with unpredictable results (AFIT/SO, 2008).

Vehicle Design Including Its Size and Its Safety Characteristics.

The design and the size of the vehicle seem to affect the risk and type of MVCs. Figure 18 reveals that vans are safer than other types of vehicles and along with sport utility vehicles (SUV's) have the lowest fatal crash rate (GAO, 03-436: 29).

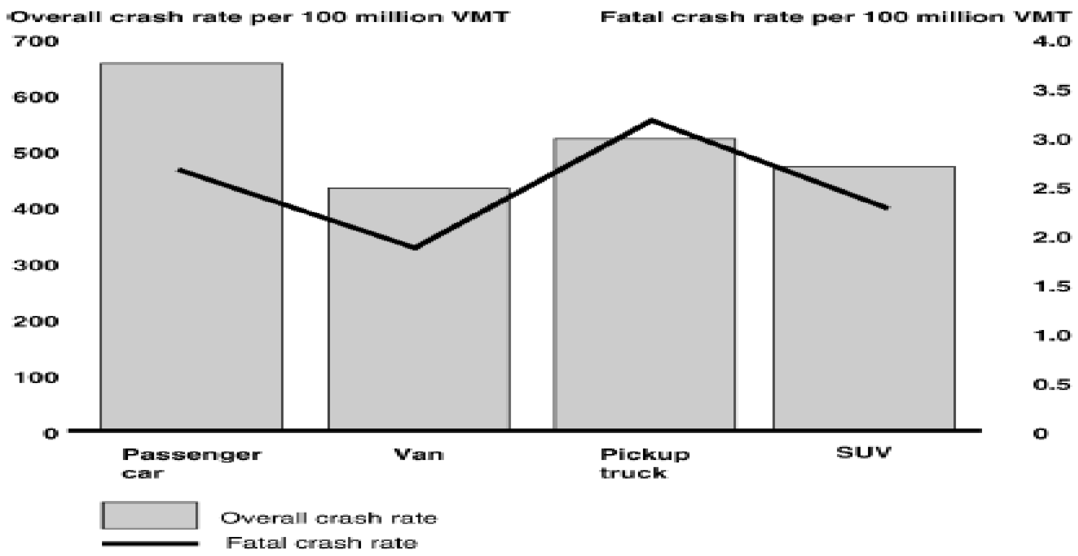

Figure 18. MVC Rate by Vehicle Type (GAO, 03-436: 29)

Additionally, some types of MVCs tend to have more serious injury outcomes than others. Rollover crashes can easily be characterized as "deadly" among the various types of collisions. About 10,100 (or almost 32%) of the 31,875 occupant fatalities in the US during 2001 occurred in rollover crashes (GAO, 03-436: 29). One possible explanation of the above dramatic result is the increase in popularity of taller SUVs, people carriers and minivans which have more top weight than standard passenger cars (Wikipedia, Car accident; 2008).

The percentages of rollover occurrence by vehicle type in 2001 are illustrated in figure 19. In accordance with figure 19 and the finding of the GAO analysis SUVs were over three times more likely to be involved in a rollover MVC than were passenger cars. Also, the proportion of SUVs that rolled over in fatal MVCs was 35% which is 2 times more than passenger cars (GAO, 03-436: 29-31).

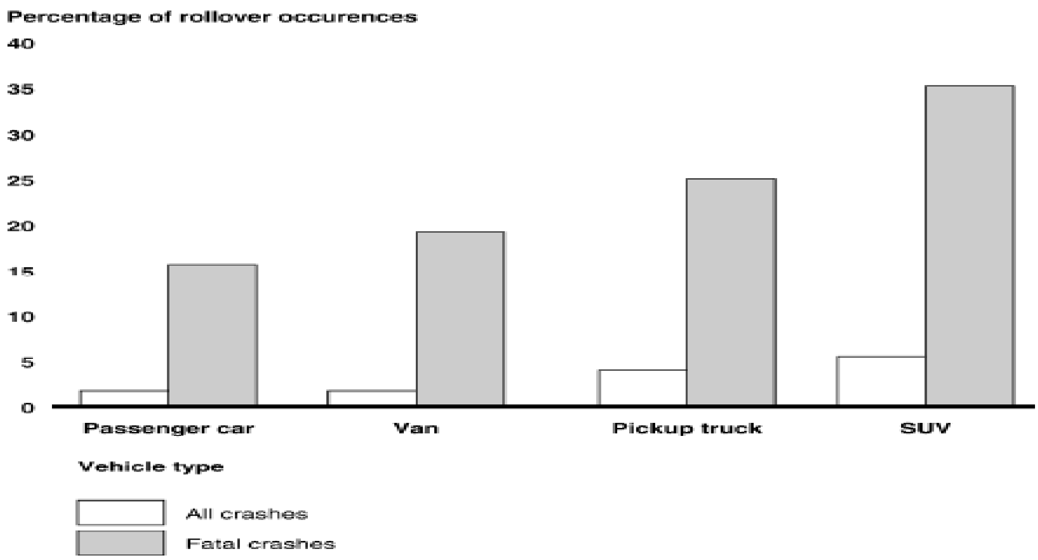

Figure 19. Rollover MVC Rates by Vehicle Type (GAO, 03-436: 30)

It is important to point out that there is an attempt currently under way by the US government to reduce the future rate of rollover fatalities. US automobile companies will have to comply with the US Federal Motor Vehicle Safety Standards and produce SUVs and vans that are more resistant to rollover crashes by 2012 (Ken, 2006).

Finally, GAO explains that according to NHTSA's Chief of Information Services statement:

> "the central problem with identifying vehicle factors is that police officers are not necessarily qualified to identify vehicle defects."
> (GAO, 03-436).

Likewise, the size of the vehicle seems to be an important issue on the occupant protection in MVCs (Evans, 1991: 64-95). Evans claims that when a small vehicle (2,000 pound) crashes into another larger vehicle (4,000 pound), then the risk of fatal injury in the large vehicle is 13 times less than it is in the small one. Moreover, a driver in a 2,000 pound vehicle crashing into another with the same weight is almost twice as likely to be killed, than a driver in a 4,000 pound vehicle crashing into another 4,000 pound vehicle (Evans, 1991: 94-95).

Furthermore, Evans states that in an MVC, the risk in a 2,000 pound vehicle is approximately 2.4 more times than in a 4,000 pound vehicle (Evans, 1991: 95). Finally, based on general physics principles, Evans makes two important conclusions associated with the vehicle size:

"1. The lighter the vehicle, the less risk posed to other road users
2. The heavier the vehicle, the less risk posed to its occupants." (Evans, 1991: 95).

For decades many public road safety agencies like NHTSA through the National Advanced Driving Simulator (NADS) and many independent road safety organizations have conducted car safety testing under real conditions, using anthropomorphic dummies and have tried to improve vehicle safety systems. The main goals of a vehicle's safety system are to reduce the risk of MVCs' occurrences and simultaneously lessen the risk of injury severity should an MVC occur.

Unfortunately, the other road users such as pedestrians, cyclists and motorcyclists do not normally have protection other than their clothing and their personal readiness. This is the basic reason why these specific groups of road users are twice as likely to suffer severe injuries as the motorized four wheeled road users (Wikipedia, Car accident; 2008).

For the purposes of this thesis, vehicle factors other than type (motorized four-wheeled (4W), two-wheeled (2W)) will be excluded from consideration as factors that impact the risk of MVCs and affect injury severity for US Air Force military personnel due to the lack of this information in AFSC data.

Vehicle related failures and vehicle design and safety are factors that can influence the risk of MVCs occurrence and the severity of the injury. Nevertheless, it seems that driver factors such as good judgment, common sense and general behavior are more important in affecting the four levels of road traffic risk.

Regrettably, experts have differing perspectives on the importance of the above factors in causing MVCs (Pless, 2004:846). For example in accordance with Vernic and Teret the factors which are most significant in order to reduce MVC fatalities are the improvement of vehicle safety systems and roadways (Vernic and Teret, 2004: 170). On the contrary, McKay asserts that the greatest focus must be placed on the use of safety belts and the reduction of alcohol usage around the US (McKay, 2004: 170-171). However, Evans believes that the key to minimizing the MVC problem in the US is to concentrate efforts on changing the drivers' behavior (Evans, 2003: 1385 & Evans, 2004: 171-172).

MVCs' Consequences

After a thorough discussion and analysis of the factors that influence road traffic risk, it is imperative to consider the results of MVCs and their economic and social impacts. This thesis will attempt to identify the factors that affect the number of lost workdays resulting from MVCs and negatively impact the US Air Force budget and consequently, the economic stability of US taxpayers. In reality, MVCs influence both the injured party and the broader society. Unfortunately, apart from MVCs' fatalities or injuries and property damage, burdensome economic costs and various psychological outcomes are among the usual consequences after MVC events (WHO, 2004: 47-51 & NHTSA, 2002; 809-446).

Fatalities & Injuries

Without a doubt, one of the worst outcomes of an MVC is the victim's death, a human loss. In fact, it is extremely difficult to put a price on human life. Additionally, MVCs injuries vary in type and severity. Table 6 reveals that brain injuries represent roughly a quarter of those suffered by victims who are injured seriously and require medical treatment in health facilities. 10% suffer open wounds and 20% have broken their lower limbs (WHO, 2004: 49).

Table 6. The 20 leading Non-Fatal MVC Injuries Sustained[a] as a Result of Global MVCs in 2002
(Reproduced from WHO, 2004: 49 with the permission of the publisher)

Type of injury sustained	Rate per 100,000 population	Proportion of all traffic injuries
Intracranial injury[b] (short-term[c])	85.3	24.6
Open wound	35.6	10.3
Fracture patella, tibia or fibula	26.9	7.8
Fractured femur (short-term[c])	26.1	7.5
Internal injuries	21.9	6.3
Fractured ulna or radius	19.2	5.5
Fractured clavicle, scapula or humerus	16.7	4.8
Fractured facial bones	11.4	3.3
Fractured rib or sternum	11.1	3.2
Fractured ankle	10.8	3.1
Fractured vertebral column	9.4	2.7
Fractured pelvis	8.8	2.6
Sprains	8.3	2.4
Fractured skull (short-term[c])	7.9	2.3
Fractured foot bones	7.2	2.1
Fractured hand bones	6.8	2.0
Spinal cord injury (long term[d])	4.9	1.4
Fractured femur (long term[d])	4.3	1.3
Intracranial injury[b] (long term[d])	4.3	1.2
Other dislocation	3.4	1.0

[a] Requiring admission to a health facility, [b] Traumatic brain injury, [c] Short-term = lasts only a matter of weeks,
[d] Long-term = last until death, with some complications resulting in reduced life expectancy.

In addition, the WHO states that MVCs are the leading factor of traumatic brain injuries universally and gives some interesting figures on global levels prior to 2004, such as:

- 13% to 31% of total hospital patients were victims of MVCs
- MVCs' victims were the most frequent users of health care facilities and units as well as X-ray departments, rehabilitation and

physiotherapy services.
(WHO, 2004: 48-49)

Regrettably, the physical and emotional pain that the MVCs' victims often suffer cannot always be alleviated nor can truly adequate compensation be provided.

Economic Impact

MVCs cause huge economic costs which are heavily burdensome for individual household budgets and the national budget alike. However, the WHO claims that estimating the economic cost of MVCs is crucial for a better awareness of the extent of this social health problem. Likewise, it will provide a comparison measure between MVCs and other health problems. This could prove to be an essential tool to validate the most cost- effective intervention programs (WHO, 2004: 47-48). This study will focus on answering the question of which factors influence the number of lost workdays which affect the US Air Force's direct costs arising from the MVCs in which its military personnel are involved.

Unfortunately, MVCs cause multidimensional impacts that influence not only the victims' lives but also those of their families, friends and society in many ways. The NHTSA explains that MVC medical costs from victims' cure and rehabilitation in terms of payments for insurance, deductibles, uncovered costs, and uninsured expenses increase the costs to society. This burden on society can be interpreted as higher insurance premiums and costs which decrease the medical resource allocation for medical research, disease prevention and control and basic public health needs (NHTSA, 2002; 809-446: 5).

Likewise, lost productivity due to workplace disruption caused by MVC related deaths or serious injuries, is a considerable cost. Besides that, the victims' dependents experience, apart from the emotional pain, various economic burdens such as the loss of victims' earnings, medical bills, funeral costs and legal bills (WHO, 2004: 52 & NHTSA, 2002; 809-446: 7).

The WHO reports that over 70% of households worldwide stated that their income, food consumption and food production had all diminished after an MVC fatality of the household head or head's spouse (WHO, 2004: 52). The NHTSA also reinforces the above finding by stating that insurance in the US does not sufficiently cover the most serious injuries. Therefore, the financial consequences can be ruinous for the victim, depending upon their original financial status and insurance coverage, and the resulting medical and rehabilitation costs, plus any loss of income (NHTSA, 2002; 809-446: 7). The broader society also shares the financial burden in terms of providing support to the victims and their dependents, and experiencing reduced national productivity due to the victims' inability to work (NHTSA, 2002; 809-446: 5).

NHTSA differentiates the MVCs' cost components into two categories, direct and indirect costs. Emergency treatment, initial medical costs, rehabilitation costs, long-term care and treatment, insurance administration expenses, legal costs, and employer/workplace costs are all considered to be direct costs. In contrast, productivity costs in the workplace due to temporary and permanent disability and decreases in household productivity originating from these disabilities are regarded as indirect costs. Property damage and travel delay, crash costs other than those directly attributable to an injury, are estimated for injury and non-injury crashes (NHTSA, 2002; 809-446: 13). A description of each of these cost components is included in Appendix A.

Table 7 shows MVCs' costs by region as a percentage of the gross national product (GNP).

Table 7. MVC Costs by Region as Percentage of GNP
(Reproduced from WHO, 2004: 51 with the permission of the publisher)

Region[a]	**GNP, 1997 (US$ billion)**	**Estimated annual crash costs**	
		As % of GNP	**Costs (US$ billion)**
Africa	370	1	3.7
Asia	2,454	1	24.5
Latin America & Caribbean	1,890	1	18.9
Middle East	495	1.5	7.4
Central & Eastern Europe	659	1.5	9.9
Subtotal	5,615		64.5
Highly-motorized countries[b]	22,665	2	453.3
Total			**517.8**

GNP: gross national product, **[a]** Data are displayed according to the regional classifications of the TRL Ltd, United Kingdom, **[b]** Australia, Japan, New Zealand, North America, and the western European countries

In accordance with the above table, the annual burden of economic costs globally is estimated at almost US$ 518 billion and in most countries the cost exceeds the 1% of GNP (WHO, 2004: 51). What is more, the WHO states that MVCs' economic impacts cause serious damages to low and middle-income countries. These economic damages are estimated to be far greater than the total annual amount received in development support. In the high-income countries of the Europe Union, the annual cost of MVCs is two times higher than is the Europe Union's annual budget for all of its activities (WHO, 2004: 51).

The NHTSA reports that the total cost (direct and indirect) of motor vehicle crashes that occurred to the US in 2000 was $230.6 billion, and represents the present value of lifetime costs for 41,821 fatalities, 5.3 million non-fatal injuries, and 28 million damaged vehicles, in both police-reported and unreported crashes (NHTSA, 2002; 809-446: 1-2). Also, this enormous cost is equal to approximately $820 for every person living in the US (NHTSA, 2002, 809-446: 1-2). Figure 20 gives the picture of the percentage distribution of each cost component to the MVCs' total (direct and indirect) cost.

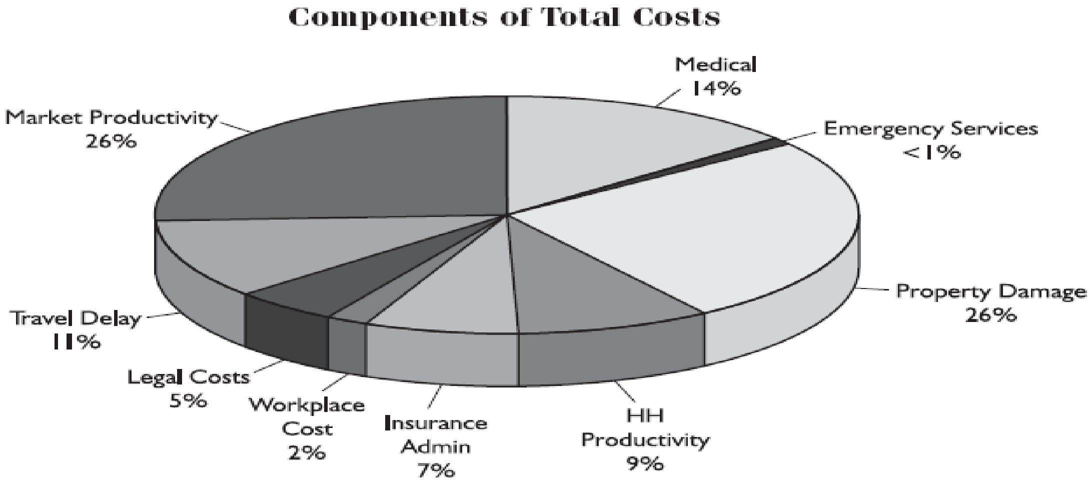

Figure 20. Cost component's % Distribution to MVCs' Total Cost in 2000 (NHTSA, 2002; 809-446: 10)

Interestingly, some of the NHTSA's additional results are that lost market productivity accounted for $61 billion of the total cost, while property damage was estimated to be in the proximity of $59 billion. Medical expenses were estimated at about $32.6 billion and travel delay costs accounted for about $25.6 billion. (NHTSA, 2002; 809-446: 1, 10).

Based on the above findings, the gravity of MVCs in terms of economic costs is revealed. However, an even more devastating fact emerges: despite these enormous economic impacts, MVCs place an even greater cost on victims; serious psychological effects that are difficult to quantify emerge in many crash incidents. Although, the purpose of this study is to deal with the factors that affect the lost workdays of the US Air Force resulting from MVCs and that negatively affect Air Force budget, it is worthwhile to briefly consider the general psychological consequences of MVCs.

Psychological Outcomes

Economic costs can not capture the psychological impacts resulting from MVCs' injuries. The NHTSA reports two common psychological consequences for victims who have experienced MVCs: Post Traumatic Stress Disorder (PTSD) and Major Depressive Episode (MDE) (NHTSA, 2002; 809-446: 63-69).

Post Traumatic Stress Disorder.

The four basic symptoms of PTSD which the MVCs' victims suffer most frequently are:

- re-experiencing, in which it is difficult for the MVCs' victims to forget the traumatic experience because they recall frequently the scenes of the MVC that they have experienced
- avoidance, in which the MVCs' victims try to reduce the risk of exposure inasmuch as they have a concern of experiencing another MVC
- numbing, which causes the MVCs' victims to not be able to care for others
- hyper arousal, in which the MVCs' victims have sleep disturbance, irritability or outbursts of anger, concentration difficulties, hyper vigilance and an exaggerated startle response.

(NHTSA, 2002; 809-446: 64).

The above symptoms of PTSD last for at least one month. However, the NHTSA clarifies that there are various types of PTSD which depend on the length of their symptoms. For example acute PTSD is defined as having symptoms for fewer than 3 months, chronic PTSD is defined as having symptoms for more than 3 months, and delayed onset PTSD is defined as having the onset of the symptoms at least 6 months after the stressing event (NHTSA, 2002; 809-446: 64).

Generally, based on both old and current studies, the prognosis for PTSD is not favorable and the time of the symptoms' manifestation after the MVC event varies among individuals. Also, the time period from the PTSD to complete recovery differs amongst victims. Furthermore, it has been observed that the MVCs' victims who have the symptoms for one year rarely recover completely (NHTSA, 2002; 809-446: 64-65).

Major Depressive Episode.

The second more prevalent psychological impact is depression. The NHTSA describes that under the MDE victims have:

"a depressed mood or loss of interest or diminished ability to derive pleasure from everyday activities plus some mix of other symptoms such as change in weight, sleeplessness, etc."
(NHTSA, 2002; 809-446: 66)

Generally, it is accepted that the symptoms of depression last 6 months or longer but there are people who can experience some of the symptoms for months or years (NHTSA, 2002; 809-446: 67). Based on NHTSA sources almost 5% to 10% percent of people diagnosed with MDE can experience the full set of symptoms for 2 years or more (NHTSA, 2002; 809-446: 67).

Actually, there is not enough evidence to verify a relationship between the age of the victims and the experience of PTSD or MDE symptoms. However, gender appears to be a significant factor with females found to have a higher risk of suffering the above two psychological outcomes (NHTSA, 2002; 809-446: 69). NHTSA estimates that as the MVCs' survival rates rise the impact of psychological problems is likely to become more profound (NHTSA, 2002; 809-446: 69).

Finally, the Mayou and others study is consistent with the above findings and claims that besides the PTSD and MDE symptoms, there are hospital anxiety and phobic travel anxiety (Mayou and others, 2001: 1231). Whatever the type of psychological effect suffered by MVCs' victims, it is able to limit or otherwise change their life dramatically, with harmful results for the individual, their families and friends.

Other Consequences

As this thesis has described above, the surviving MVC victims experience not only economic burdens but also psychological impacts. Moreover, the above unfortunate consequences do not only affect the victims but also their families and friends. The victims' families and friends feel almost the same emotional pain as the victim and they often change their daily lives in order to support and help the victims' through their distress and rehabilitation.

NHTSA states that the economic, psychological and emotional problems that the surviving MVC victims experience influence the other members of the family and try the family units' cohesiveness. When the worst scenario happens, an MVC fatality occurrence, the emotional suffering is even deeper, with unpredictable outcomes for the family members and friends for years afterward. This tragedy can sometimes cause the breakup of a balanced family tie (NHTSA, 2002; 809-446: 7).

The WHO estimates that without increased attempts and new initiatives, the total number of MVC fatalities and injuries will increase universally by 65% by 2020 in comparison with the current dispiriting MVC's figures (WHO, 2004: 3). Jones and others attempted to develop a procedure as a solution to managing public health problems. Their approach includes the implementation of prevention strategies and programs and the continual surveillance and monitoring/evaluating the effectiveness of these prevention initiatives (Jones and others, 2000; 18: 72).

Therefore, the improvement of the current intervention strategies or establishment of more efficient programs would be beneficial in preventing or decreasing the frequency and severity of MVC events amongst US Air Force military personnel.

Intervention Programs

The main purpose of intervention programs is to minimize the road traffic risk elements, the risk exposure, the MVC involvement risk, the risk of injury and the severity of injury outcome (WHO, 2004: 109-143).

The WHO believes that the reduction of the risk exposure to the road traffic environment can be achieved by good transport and land-use policies. Likewise, the institution of measures against aberrant driver' behaviors and enforcement of the laws, in conjunction with information and education on traffic safety issues, seems to be the answer to decreasing the MVC involvement risk and the risk of injury. The MVC's risk of occurrence and injuries can also be diminished through the improvement of the vehicles' crash-protective system and safety-conscious planning and design of the road network. Finally, the development and maintenance of well organized emergency, treatment and rehabilitation systems is able to minimize the severity of the injury outcomes (WHO, 2004: 109-143).

The US Air Force through the AFSC has issued numerous regulations or instructions and has put into practice several intervention programs to reduce the number of MVCs in which its personnel are involved. Over the last five years, the AFSC has instituted a number of initiatives aimed directly at preventing or reducing the frequency and severity of vehicular mishaps involving Air Force personnel – including taking the following actions:

- Establishment of a traffic safety branch within SEG which has aided in energizing the major command (MAJCOM) and subordination of safety offices to implement a more aggressive traffic safety oversight and culture improvement
- Partnerships with sister services and the private sector, such as the Motorcycle Safety Foundation, Specialty Vehicle Institute of America, and the Governor's Highway Safety Council, to coordinate traffic safety mishap prevention efforts
- Revision of all of the AF traffic safety courses, including the development and implementation of Course IIIA, Intermediate Traffic Safety, and IIIB, Advanced Traffic Safety with both courses targeting first term Airmen
- Addition of a Traffic Safety Module to Supervisor's Safety Training
- Establishment of requirements for a motorcycle mentorship program and for unit commanders to be aware of who their units' motorcyclists are
- Intensified traffic safety efforts during seasonal campaigns, e.g., 101 Critical Days
- Partnership with the Department of Transportation's Traffic Safety Institute to develop a Traffic Safety Manager's Program course which numerous USAF safety warriors have already attended (AFSC, 2008).

One of the most popular US Air Force intervention programs is the "101 Critical Days of Summer" campaign. This program, launched in the late 1960's, runs annually to counter the usual increase in Air Force mishaps and deaths that occur during the summer period (between Memorial Day and Labor Day) each year. Traditionally this period is a season of greater risk to Airmen as they spend more time traveling and engage in more outdoor activities than they do in the other seasons (AFSC, 2008).

Additionally, this campaign focuses on increasing personal readiness against possible risks and thereby aims to reduce the number of summer mishaps and fatalities. Other traditional attempts include: messages by senior leadership, briefings by commanders, weekly supervisory briefings, pre- trip/travel/departure briefings and presentations, etc. (AFSC, 2008).

These interventions may have decreased the MVC fatalities and injuries. The rate of fatalities per 100,000 US Air Force military personnel dropped from 21.86 in F.Y. 1988 to 12.77 in F.Y. 2007.

Figure 21 describes some of the most essential military injury prevention partners that play a crucial role in the Department of Defense and military services' efforts to develop and apply more efficient intervention strategies (Jones and others, 2000: 81-83).

Figure 21. Key Military Injury Prevention Partners
(Reproduced from Jones and others, 2000: 83 with the permission of the publisher)

Finally, according to the Jone and others' article, an advisory council for the above key partners should be formed in order to help coordinate, focus, and prioritize injury prevention activities in the military services (Jones and others, 2000; 81).

One of the basic purposes of this thesis is to attempt to improve the US Air Force data analysis of MVCs to obtain more effective understandings that can assist the US Air Force policy makers in making better decisions and apply more efficient intervention programs specifically tailored to various groups of Air Force military personnel.

Finally, it is important to point out that accurate data and its maintenance are essential, not only for prioritizing health problems or observing trends, but also for building and evaluating prevention policies (WHO, 2004: 61). The WHO, under the doctrine that MVC deaths and injuries are preventable, advises that the three basic elements of traffic system, road users, road infrastructure and vehicles, should be addressed so that multi-sector strategic policies can be developed (WHO, 2004: 109).

Summary

MVCs are a growing global public health concern with economic and psychological outcomes for the victims, their family and/or friends, and society. During recent years many studies have been carried out in order to address the causes that influence road traffic risk elements. This thesis, consistent with the above research, analyzed the three main categories of factors that seem to affect the occurrence of MVCs and their grievous results. These factors are: human factors, roadway environment factors, and vehicle factors. Drivers' behaviors and characteristics appear to be, according to the majority of the literature reviews and experts, at the core of the MVC events and are the factors that most influence the four road traffic risk elements. This study will focus on the identification of risk factors that are related to MVCs, factors that are associated with alcohol consumption and factors that influence the severity of injuries suffered by US Air Force military personnel. In addition this thesis has provided an analysis of the economic costs and psychological impacts to the MVC victims, their families, friends and society and has defined the purpose and goals of intervention programs, particularly those policies implemented by the US Air Force. This research will examine the factors that affect the number of lost workdays that have been caused by MVCs in which military personnel are involved and which often detrimentally influence the US Air Force's direct costs. Finally, this thesis hopes the above analysis will provide valuable input to US Air Force policy makers in order to improve the US Air Force prevention program's decision making process.

III. Methodology

Research Approach

The AFSC data and their structure drive the methodology of this thesis. This study using the AFSC data for MVCs in which US Air Force military personnel are involved intends to apply categorical data analysis and factorial analysis to address the policy objectives and deal with the research questions which have been defined in Chapter I.

Database

This research effort will employ the US AFSC data in order to carry out its analysis. The MVC data collected by the AFSC from F.Y. 1988 through F.Y. 2007 contain data for MVCs in which US Air Force military personnel were involved when they were off duty and off base. More specifically, the AFSC data include demographic figures, such as gender, rank and age of military personnel who were involved in an MVC event. The AFSC data also contain information about the date and time of the crash, type of vehicle, mishap class, type of injury, whether the victims wore a seatbelt and if there was a toxicological (TOX) test after the incident. In cases in which there was a TOX test after the MVC occurrence (this indicated by "Yes," -otherwise by "No" under the column titled "Alcohol Involved") the data include the results of this test in terms of Blood Alcohol Concentration (BAC) percentage. Finally, the data incorporate figures on lost days from work and hospitalized days.

Categorical Data Analysis

The various qualitative variables and numerous levels contained in the AFSC data are the basic reasons that this research relies on conducting hypothesis tests on multinomial probabilities to identify risk factors that are related to MVCs and which influence the type of injuries.

More specifically, this research uses the chi-square distribution in order to make inferences about category probabilities for data -classified according to either a single qualitative variable or two variables. Finally, this study will conduct various hypothesis tests on the proportions and make inferences based on these tests.

Testing Category Probabilities: One-Way Table.

This thesis will attempt to apply the Chi-Square Test: One-Way Table in order to test several hypotheses about the proportions in each of the categorical variable levels in relation to the relevant MVC events.

This study is going to use the Chi-Square Test: One-way Table at $\alpha=0.01$ level of significance, in order to find answers for the following research questions:

1. Whether the factors of gender, age and rank of US Air Force military personnel affect the risk of MVCs.

2. Whether the time of day influences the risk of MVCs.

3. Whether the type of vehicle (motorized four-wheeled, two-wheeled) impacts the risk of MVCs.

4. Whether alcohol (for the cases for which there was a TOX test) is associated with the risk of MVCs. This thesis considers that the alcohol variable has three levels based on the TOX results as below:

   (i) Blood Alcohol Concentration (BAC) equal to 0.00,

   (ii) BAC between 0.01 and 0.07, and

   (iii) BAC between 0.08 and 0.29.

This study points out that, according to the US Alcohol Policy Information System (APIS) website (APIS; 2008) and NHTSA (NHTSA, 2008; 810-920: 1), as of

January 2007, in all 50 States, as well as the District of Columbia, and Puerto Rico, it is illegal to drive or operate 4-wheeled or 2-wheeled vehicles with a BAC of .08 grams per deciliter or above. Also, the upper level of the BAC for this research is 0.29% BAC because any grams per deciliter above this % can cause possible death (Virginia Tech, 2008).

Finally, this thesis will construct and interpret a 99% Confidence Interval for the true proportion of the high risk categorical variables' classes.

Testing Category Probabilities: Two-Way (Contingency) Table.

According to McClave, and others, the Chi-Square: the Two-Way (Contingency) Table method is suitable in situations in which there is one categorical response variable and one categorical predictor variable and the focus of interest is on whether the predictor variable has an effect on the response (McClave and others, 2008: 564 & 569).

This study is going to use the Chi-Square Test: Two-way (Contingency) Table at $\alpha = 0.01$, level of significance in order to deal with the following research questions as to affect of predictor variables on the response variable:

1. The response variable is the type of injury with four levels as presented below:

(i) Fatality: "MVC that results in death from an accident or the complications arising therefrom, regardless of the length of time intervening between the accident and a subsequent death."
(DoD, 2008: 34).

(ii) Permanent Total or Partial Disability (PT or P Dis) where:

"**Permanent Total disability** is any nonfatal injury or occupational illness that, in the opinion of competent medical authority, permanently and totally incapacitates a person to the extent that he or she cannot follow any gainful occupation and results in a medical discharge or civilian equivalent. (The loss, or the loss of use of both hands, both feet, both eyes, or a combination of any of those body parts as a result of a single accident will be considered as a permanent total disability.)

Permanent Partial Disability is an injury or an occupational illness that does not result in death or permanent total disability, but, in the opinion of competent medical authority, results in permanent impairment through loss or loss of use of any part of the body, with the following exceptions:

loss of teeth, loss of fingernails or toenails, loss of tip of fingers or tip of toe without bone involvement, inguinal hernia, if it is repaired, disfigurement and sprains or strains that do not cause permanent limitation of motion."

(DoD, 2008: 34-35).

(iii) Lost Time Case: "A nonfatal traumatic injury that causes any loss of time from work beyond the day or shift it occurred, or a nonfatal non-traumatic illness and/or disease that causes disability at any time." (Department of Defense (DoD), 2008: 15).

(iv) Minor Injuries. This level includes the following cases:

1st Aid Case - Lost Time Hrs – Treated & Released.

The predictor variables are as follows:

a. Gender of the US Air Force military personnel with two levels:

(i) Male

(ii) Female

b. Age of the US Air Force military personnel with four levels:

(i) 17 – 24

(ii) 25 – 34

(iii) 35 – 44

(iv) 45 and older

c. Rank of the US Air Force military personnel with five levels:

(i) Airman

(ii) Non Commission Officer (NCO)

(iii) Senior NCO

(iv) Company Grade

(v) Field Grade

2. Whether the type of injury which is the response variable with four levels (as described above) is influenced by the Time of Day which is the predictor variable with the below six levels:

(i) 0200 – 0559

(ii) 0600 – 0959

(iii) 1000 – 1359

(iv) 1400 – 1759

(v) 1800 – 2159

(vi) 2200 – 0159

3. Whether the type of injury which is the response variable with four levels (as described above) is affected by the type of vehicle which is deemed as predictor variable with two levels as below:

(i) Motorized four-wheeled

(ii) Motorized two-wheeled

4. Whether the seatbelt is associated with the type of injury when an MVC occurred. In that case, the response variable is the type of injury with four levels (as described above) and the predictor variable is the seatbelt with two following levels:

(i) Seatbelt Usage

(ii) Non Seatbelt Usage

5. Whether the seatbelt (response variable with two levels as above) is associated with the following predictor variables, when a MVC event occurred:

(i) Gender of the US Air Force military personnel with two levels (as described above)

(ii) Age of the US Air Force military personnel with four levels (as described above)

(iii) Rank of the US Air Force military personnel with five levels (as described above).

Finally, this thesis will construct and interpret a 99% Confidence Interval for the true proportion of some of the above categorical variables' classes.

Analysis of Variance (ANOVA) - Factorial Analysis

Based on McClave and others, the factorial analysis is appropriate for situations where there is one continuous response variable and numerous categorical predictor variables, often at two levels and the area of interest is which predictor variables, including the interactions among them, affect the response (McClave and others, 2008: 521 & 522).

Therefore, this study applied the above method in order to:

1. Address the 1st research question of the 2nd objective which is what factors are associated with the alcohol consumption for those MVCs in which US Air Force military personnel were involved and for which there was a toxicological (TOX) test.

and

2. Deal with the 2nd research question of the 2nd objective which is the identification of factors that affect the number of Lost Days resulting from MVCs in

which US Air Force military personnel were involved and affect the total MVCs' direct costs.

Response Variable.

According to McClave and others:

"The response variable is the variable of interest to be measured in the experiment and also it is known as dependent variable."

(McClave and others, 2008: 476).

For the above 1st case, this research is going to use the Alcohol Level in terms of the BAC measured by the TOX test as the response variable. Also, for the 2nd case, the response variable is the Total Lost Days, which is the sum of Days Hospitalized and Days Qtrs (Days at home) resulting from the MVCs and affecting the total MVCs' direct costs.

This thesis during its effort to deal with the 2nd investigative question of the 2nd objective of its analysis encountered an issue through the original data concerning the calculation of the lost days in cases of the fatal and permanent total or partial disabilities injuries. Lost days have been calculated in only 24 of 1,104 fatal cases and 74 of 242 PT or P Dis cases while the remaining cases were listed with zero lost days. Also, the above non zero cases correspond to the hospitalized days and not to the lost work days.

This research believes that the above two types of injury cause lost work days which are beyond the detailed hospitalized days for members of the USAF. Moreover, since there is no method to estimate these lost days, this study is going to define its own method of extrapolating the lost days for the fatal and PT or P Dis injuries.

This thesis issued two possible scenarios for specifying the lost days in these cases and will discuss them separately in Appendix B. The main purpose for presenting each scenario separately is to provide policy makers the opportunity to select the scenario which best suits with their requirements.

Factors (Predictor Variables), Levels – Treatments.

McClave and others define that:

“1. **Factors** are those variables whose effect on the response is of interest to the experimenter. Quantitative factors are measured on a numerical scale, whereas qualitative factors are those that are not (naturally) measured on a numerical scale. Factors are also referred to as independent variables.

2. **Factor Levels** are the variable of the factor utilized in the experiment.

3. **The treatments** of an experiment are the factor-level combinations utilized.”

(McClave and others, 2008: 476-477).

The literature review of this study identified many factors that influence, not only the alcohol consumption, but also the risk of MVC events as well as the number of Lost Days. The majority of these variables are associated with human factors which this thesis believes can be controlled by the US Air Force. The basic reason that this study attempts to identify the factors that are most closely related with Alcohol consumption and those which have the most serious impact upon the number of Total Lost Days is to attain information that can help the US Air Force policy makers make better decisions and design more effective intervention programs, specifically tailored to various categories of Air Force military personnel.

Table 8 presents the factors that will be tested using the AFSC data, in order to examine the relationship of these variables to Alcohol consumption by USAF military personnel who have been involved in MVCs.

Table 8. List of Factors (Independent Variables) for the Alcohol Consumption ANOVA

VARIABLE DESCRIPTION	VARIABLE NAME
1. Time of Day	DAYT
2. Gender	GEN
3. Rank	RANK
4. Age Groups	AGE
5. Type of Injury	INJ
6. Seatbelt	SEATB

Table 9 lists the factors that will be examined using the AFSC data, in the hope of finding the effect of these variables on the number of Lost Days resulting from the MVCs in which the USAF military personnel were involved and which negatively influence the US Air Force combat power, productivity, budget and mission.

Table 9. List of Factors (Independent Variables) for the Lost Days ANOVA

VARIABLE DESCRIPTION	VARIABLE NAME
1. Time of Day	DAYT
2. Gender	GEN
3. Rank	RANK
4. Age Groups	AGE
5. Activity	ACT
6. Type of Injury	INJ
7. Alcohol Level	BAC
8. Seatbelt	SEATB

The description of the above factors is as follows:

1. Time of Day: The levels of this factor are the following six time periods:

(i) 0200 – 0559

(ii) 0600 – 0959

(iii) 1000 – 1359

(iv) 1400 – 1759

(v) 1800 – 2159

(vi) 2200 – 0159

2. **Gender:** This factor includes the following two levels:

(i) Male

(ii) Female

3. **Rank:** This factor has five levels:

(i) Airman

(ii) Non Commission Officer (NCO)

(iii) Senior NCO

(iv) Company Grade

(v) Field Grade

4. **Age Groups:** The levels of this factor are five as the following age categories:

(i) 17 – 25

(ii) 26 – 30

(iii) 31 – 35

(iv) 36 – 40

(v) 41 and older

5. **Activity:** This factor has the below two levels:

(i) Driver

(ii) Passenger

6. **Injury Groups:** The levels of this factor are four as follows:

(i) Fatality

(ii) Permanent Total or Partial Disability (PT or P Dis)

(iii) Lost Time Case

(iv) Minor Injury

7. Alcohol Level (BAC): The levels of this factor are three as below:

(i) 0.00 – 0.00

(ii) 0.01 – 0.07

(iii) 0.08 – 0.29

8. Seatbelt: This factor has the three following levels:

(i) Yes or “Y” (for the belted occupants of the 4W vehicle MVCs)

(ii) No or “N” (otherwise)

(iii) “Z” in case of 2W vehicle MVCs in which the seatbelt as an item of safety equipment does not exist.

Finally, this thesis can claim that the above models satisfy the assumptions required for valid F-Tests in Factorial Experiments.

Summary

This chapter described the database and comprehensively discussed the methodology applied by this study in order to address the policy objectives and find answers for the investigative questions set forth in Chapter I. Furthermore, the response and predictor variables which this research will use to deal with the 1st objective were outlined.

A thorough introduction was also made of the factors with their levels and method used to develop the general linear model in order to tackle the 2nd objective. Finally, this chapter outlined the development of the models and the mode of analysis that will be carried out in the next chapter.

IV. Analysis and Results

Chapter Overview

This chapter mainly discusses the outcomes of the analysis described in Chapter III. It will be recalled that the main purpose of Chapter III was to discuss the methodology applied to conduct this study and to answer the research questions presented in Chapter I and Chapter III, in greater details. In this chapter, this thesis first presents some general outcomes of its analysis and continues with the description of its analysis results in order to deal with the first policy objective which was the identification of risk factors that are related to MVCs and that can influence the severity of injuries.

Results of the Categorical Data Analysis

General Trends.

The tables, figures and inferences in the following pages describe statistics based on the MVC data collected by the AFSC from F.Y. 1988 through F.Y. 2007 and contain data for MVCs in which US Air Force military personnel were involved as drivers and passengers when they were off duty and off base.

Table 10 summarizes the USAF Private Motor Vehicle (PMV) mishaps by type from F.Y. 1988 through F.Y. 2007

Table 10. USAF PMV Mishaps, F.Y.: 1988-2007

TYPE OF MISHAP	NUMBER
Fatal	1,048
Injury	11,034
Other/Unknown	321
TOTAL	**12,403**

Figure 22 provides a graphical representation of the USAF PMV Mishap rate per 100,000 USAF military personnel from F.Y. 1988 through F.Y. 2007.

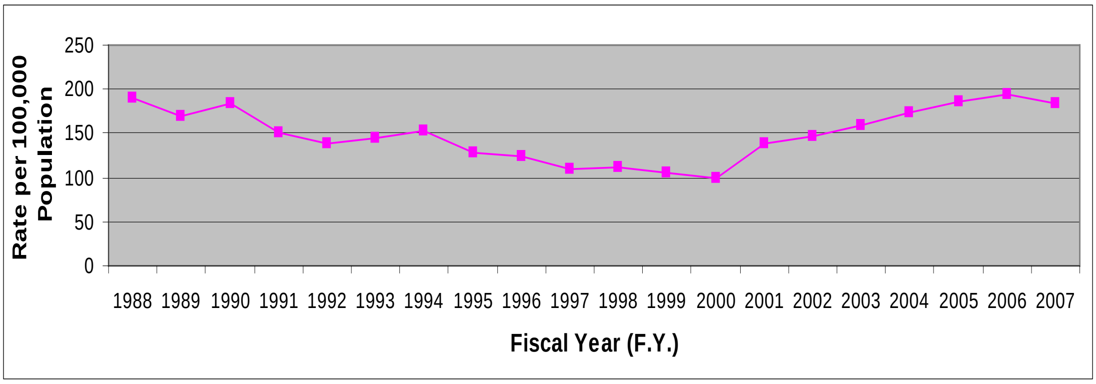

Figure 22. USAF PMV Mishap Rate per 100,000 Military Personnel

According to the AFSC data and as the above figure displays, the USAF MVCs decreased by 9.88% from 2006 through 2007 but the 2007 MVC rate, 183.09 crashes per 100,000 USAF military personnel, is still close to the 1988 rate, -which was 191.03 crashes per 100,000 USAF military personnel.

Figures 23 and 24 depict the rates of the fatal and injured PMV Mishaps respectively per 100,000 USAF military personnel from F.Y. 1988 through F.Y. 2007.

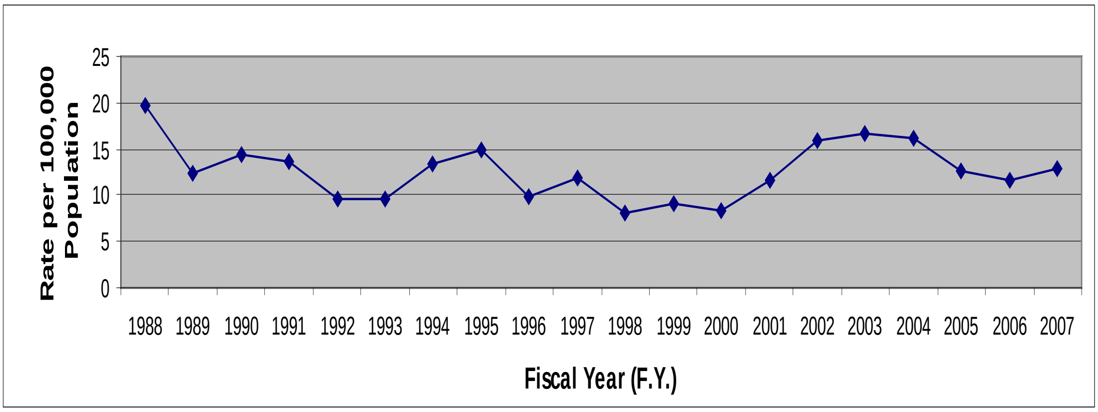

Figure 23. USAF Fatal PMV Mishap Rate per 100,000 Military Personnel

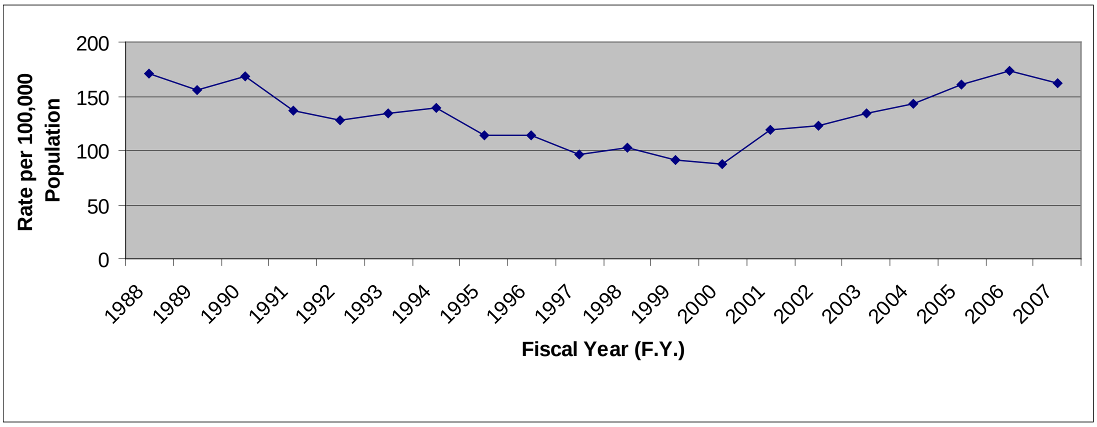

Figure 24. USAF Injured PMV Mishap Rate per 100,000 Military Personnel

The data analysis showed that the fatal PMV mishaps increased by 5% from 2006 through 2007 and the injured PMV mishaps decreased by 6.72% from 2006 through 2007.

Table 11 depicts a snap-shot of the traffic crash victims by injury type during the twenty year period (F.Y.: 1988-2007).

Table 11. Traffic Crash Victims, F.Y.: 1988-2007

OCCUPANTS	FATALITY	PERMANENT TOTAL or PARTIAL DIS	LOST TIME CASE	MINOR INJURY	OTHER/ UNKNOWN	TOTAL
Driver	867	191	9,699	247	276	11,280
Passenger	237	51	1,982	160	78	2,508
TOTAL	1,104	242	11,681	407	354	13,788

Figures 25 and 26 illustrate the rates of the fatalities and injuries respectively of MVCs per 100,000 USAF military personnel as drivers and passengers from F.Y. 1988 through F.Y. 2007.

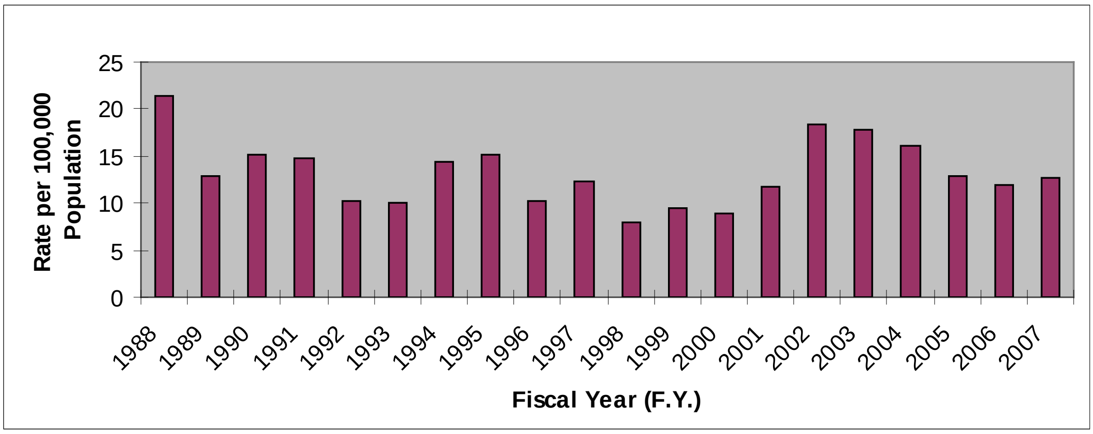

Figure 25. USAF Fatality Rate per 100,000 Military Personnel

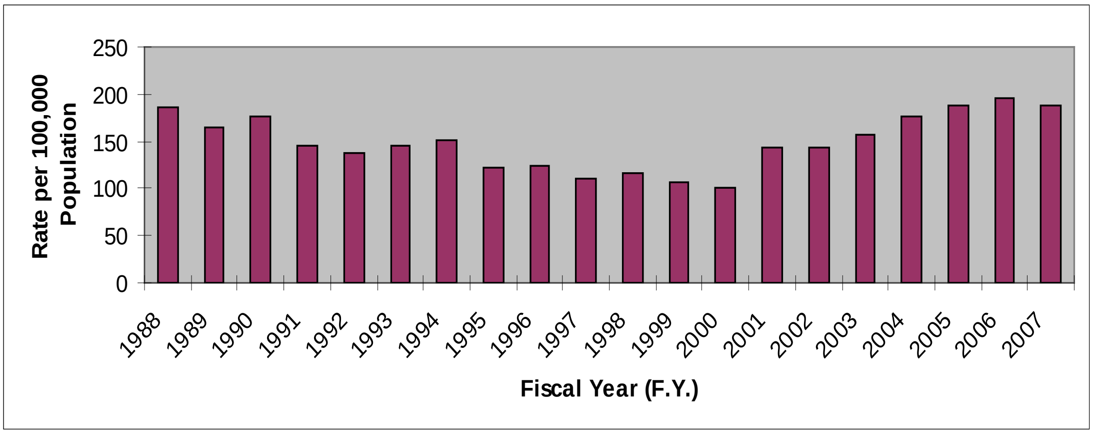

Figure 26. USAF Injury Rate per 100,000 Military Personnel

The data analysis showed that the fatality rate rose to 12.77 fatalities from 11.91 fatalities per 100,000 USAF population in 2006 and the injury rate declined to 187.65 injuries from 195.21 injuries per 100,000 USAF population in 2006.

Furthermore, the results of the analysis provided evidence which supports with 99% confidence the assertion that the proportion of USAF members who were in MVCs as drivers is 62.42% to 64.82% higher than that of those members who were in MVCs as passengers.

In addition, this study examined whether the Type of Injury caused by the MVCs and the Activity (Driver or Passenger) are dependant. The analysis gave strong evidence to conclude that the Type of Injury and Activity are not independent but are statistically dependent at $\alpha = 0.01$ level of significance. Therefore, this thesis can infer with 99% confidence that the proportion of USAF passengers who died in MVCs is 0.19% to 3.56% higher than that of USAF drivers.

Moreover, USAF members had the same proportion of suffering Permanent Total or Partial Disability (PT or P Dis) either as drivers or passengers but the proportion of experiencing a Lost Time Case is 4.40% to 8.75% greater if these members were drivers instead of passengers. Lastly, the proportion of USAF passengers who suffered Minor Injuries in MVCs is 2.99% to 5.69% larger than that of USAF drivers.

Following on from the above inferences concerning the general trends of the USAF MVCs, this thesis will continue to answer the investigative questions presented in Chapters I and III related to the categorical data analysis.

Investigative Questions Answered.

This thesis points out that the level of significance for the following statistical inferences is $\alpha = 0.01$ and that these inferences pertain to the MVCs in which the USAF military personnel were involved as drivers unless other status is specified. Also, conclusions related to the Gender and Rank of the USAF military personnel have been reached taking into consideration the total strength of each of the above variables through the twenty years of AFSC data unless another factor is specified (such as the total number of the MVCs and not the total strength). The same parameters apply to the inferences made about the USAF Age Groups, which are based on a 14 – year history instead of a 20 – year history due to the lack of data provided for USAF Age Groups before F.Y. 1994.

1st Policy Objective.

As this thesis stated in Chapter I, the 1st policy objective of this research attempt was to identify the risk factors that cause MVCs and may influence the severity of injuries. For that reason, a set of exploratory questions was set up. In the following paragraphs this study will reply to these research queries one by one.

1. Whether the factors of the Gender, Age and Rank of US Air Force military personnel affect the risk of MVCs.

Risk of MVCs and Gender.

The results of the analysis did not provide strong evidence to support that the risk of MVCs and gender are statistically dependent. Figure 27 depicts the male and female MVC rates from F.Y. 1988 through F.Y. 2007. It is obvious that there is no significant difference between the two rates.

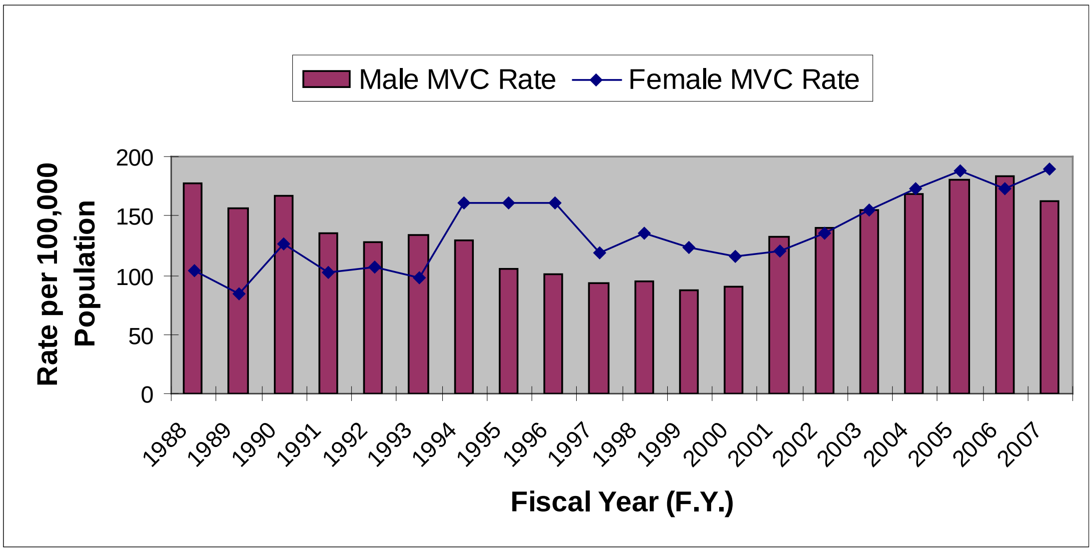

Figure 27. Male vs. Female MVC Rate per 100,000 Military Personnel

So, this thesis supports with 99% confidence that, for a given USAF member who is male, the probability that he was a driver in an MVC was almost the same as the probability for a given USAF female member.

Risk of MVCs and Age – Rank.

Concerning the Age and the Rank of USAF military personnel, the results of the analysis provided strong evidence to support the assertion that MVCs and Age and/or MVCs and Rank among USAF military personnel are both statistically dependent.

This thesis suggests that the USAF age group which most is at greatest risk for an MVC is military personnel aged 17-24 years. Figure 28 presents the Confidence Interval (CI) Plots for the probability of MVCs per Age Group, at the 99% confidence level.

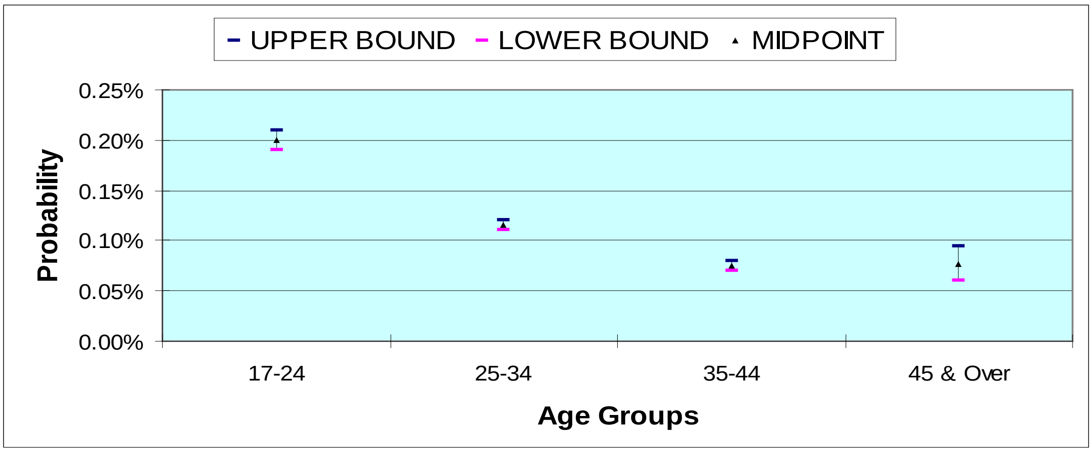

Figure 28. Confidence Interval Plots for the MVC Probability per Age Group

Finally, figure 29 illustrates the comparison among USAF Age Groups per 100,000 USAF population from F.Y. 1994 through F.Y. 2007.

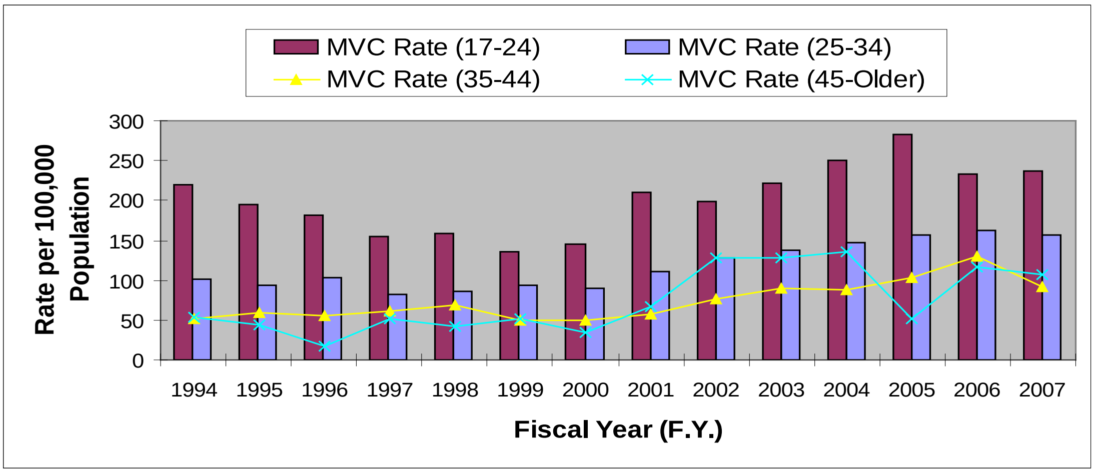

Figure 29. Age Group MVC Rate per 100,000 Military Personnel

The above graphs support this thesis assertion.

Furthermore, the outcomes of this analysis recommend that the USAF rank which most is at highest risk for an MVC is the rank of Airman. Figure 30 maps the CI Plots for the probability of MVCs per Rank Group, at the 99% confidence level.

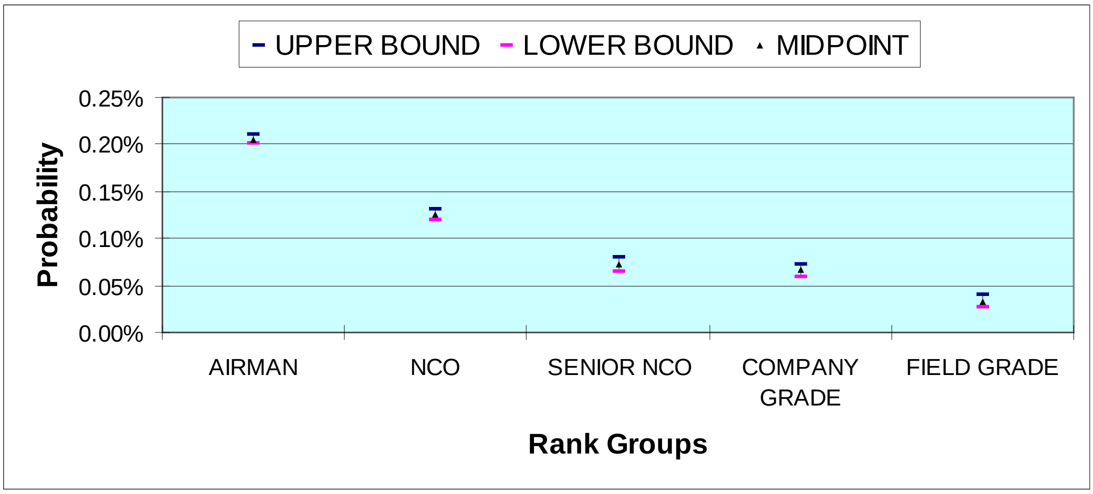

Figure 30. Confidence Interval Plots for the MVC Probability per Rank Group

Lastly, figure 31 displays the comparison among the rank groups per 100,000 USAF population from F.Y. 1988 through F.Y. 2007; this information also supports this thesis deduction.

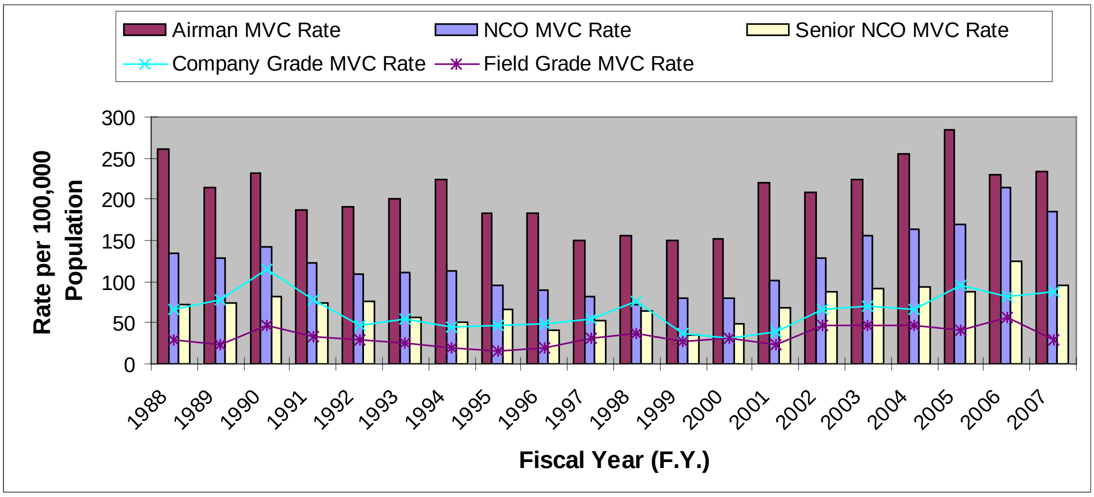

Figure 31. Rank Groups MVC Rate per 100,000 Military Personnel

2. Whether the Time of Day influences the risk of MVCs.

The outcomes of this analysis revealed strong evidence to suggest the existence of a difference in the proportion of the Time of Day in which USAF military personnel were involved in MVCs. The most risky time period of the day seems to be between 1400 and 1759 hours.

Furthermore, figure 32 depicts the CI Plots for the proportion of MVCs per Time of Day, at the 99% confidence level.

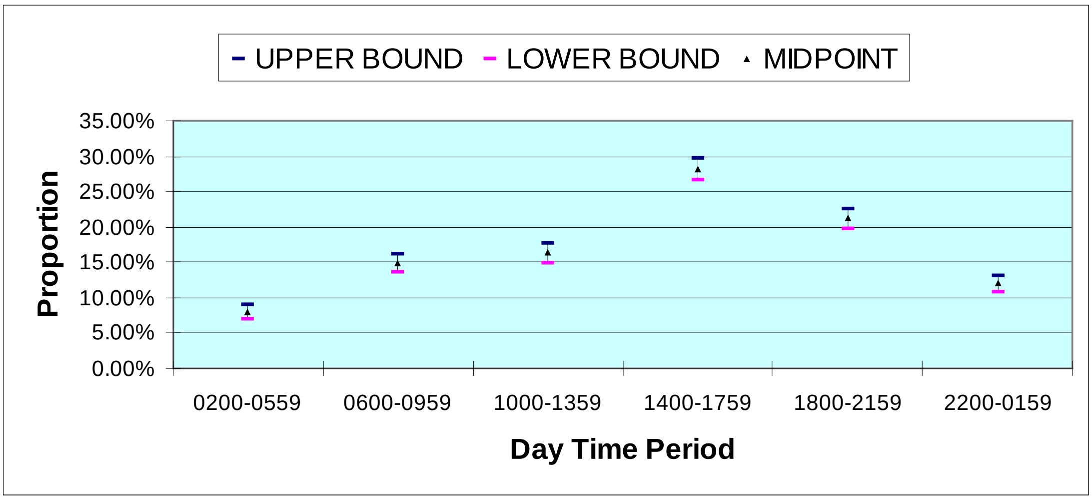

Figure 32. Confidence Interval Plots for the MVC Proportion per Time of Day

Finally, figure 33 provides a graphical comparison among the Time of Day MVC percentages (%) from F.Y. 1997 through F.Y. 2007.

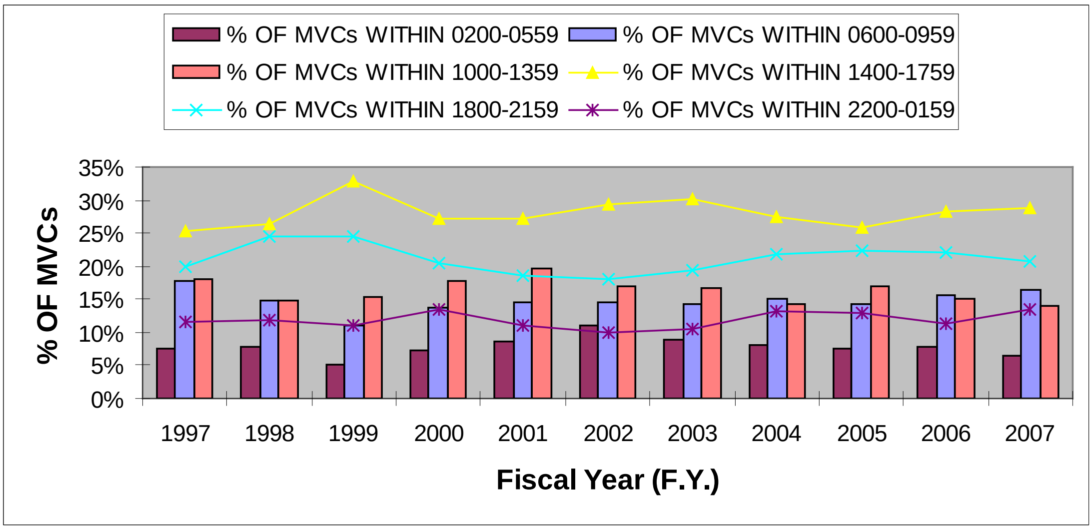

Figure 33. MVC Percentages by Time of Day

3. **Whether the type of vehicle (motorized four-wheeled (4W), two-wheeled (2W)) impacts the risk of MVCs.**

The results of the analysis provided evidence to demonstrate that the proportion of USAF military personnel who were involved in MVCs as drivers-using 4W vehicles is different to the proportion of USAF military personnel who were involved in MVCs as drivers using 2W vehicles.

This research asserts with 99% confidence that the proportion of USAF members who were drivers of 4W vehicles in MVCs is 34.50% to 37.70% higher than that of those members who were drivers of 2W vehicles. Figure 34 provides a pictorial presentation of the contrast between 4W and 2W vehicle MVC percentages (%) from F.Y. 1988 through F.Y. 2007.

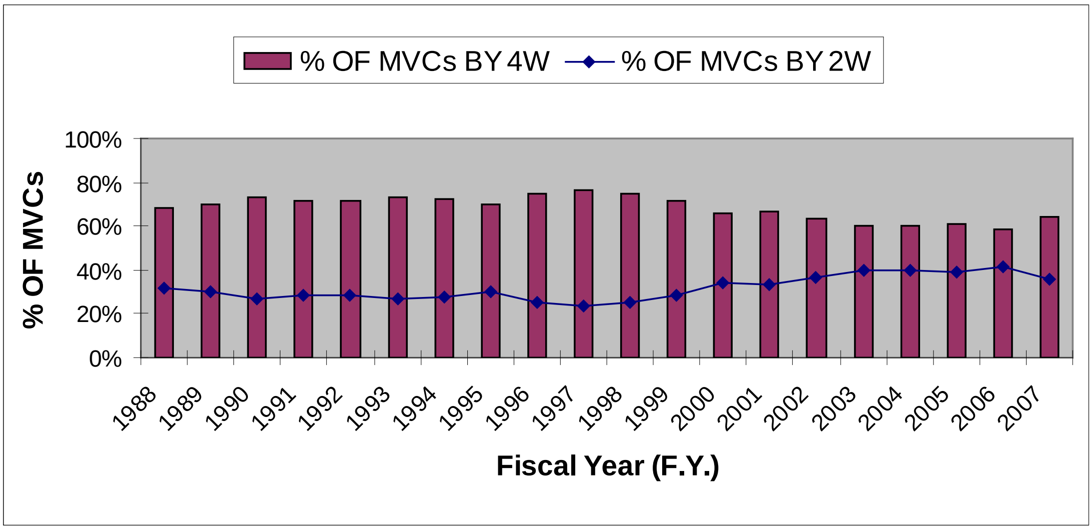

Figure 34. MVC Percentages by Type of Vehicle

4. **Whether alcohol (for those cases for which there was a TOX test) is associated with the risk of MVCs.**

The results of the analysis provided strong evidence to conclude that there is a difference in the proportion of the Air Force military personnel's BAC groups who were involved in MVCs. However, this analysis cannot reach any conclusions about the relation between alcohol consumption and the risk of MVCs because TOX tests were not conducted for all of the MVCs in the data. TOX tests were performed only for a small number of MVCs, most likely in cases in which there were strong indications that the drivers had consumed alcohol before driving.

Therefore, this thesis can state with 99% confidence that provided a USAF member was in an MVC as a driver and a TOX test was conducted for this member after the MVC, the proportions of each BAC level are as follows:

(i) BAC equal to 0.00 is 7.71% to 13.42%

(ii) BAC between 0.01 and 0.07 is 10.07% to 16.38% and

(iii) BAC between 0.08 and 0.29 is 72.58% to 80.47%.

Finally, figure 35 demonstrates the comparison among the BAC levels from F.Y. 1988 through F.Y. 2007, which also supports these thesis findings concerning the BAC proportions.

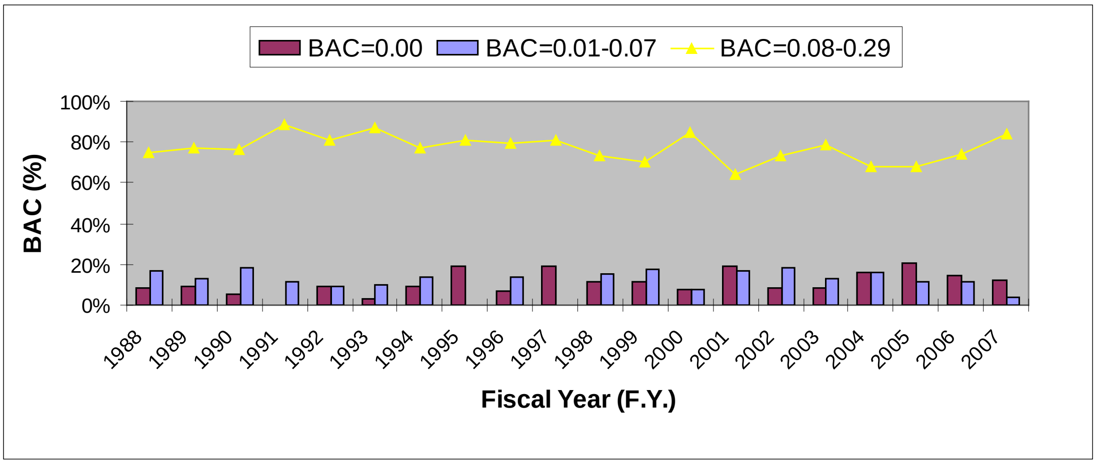

Figure 35. BAC Level Percentages by F.Y.

5. Whether the Type of Injury are affected by the Gender, Age and Rank of the US Air Force military personnel.

Type of Injury and Gender.

The results of the analysis provided strong evidence to conclude that the Type of Injury and Gender of the USAF military personnel are statistically dependent.

This thesis asserts with 99% confidence that for a given male member of the USAF the probability that he:

(i) died in an MVC as a driver was 0.004% to 0.008% higher than the probability of a given USAF female member having died in an MVC as a driver. Figure 36 illustrates the contrast among USAF Gender fatality rates per 100,000 USAF population from F.Y.: 1988 through F.Y. 2007.

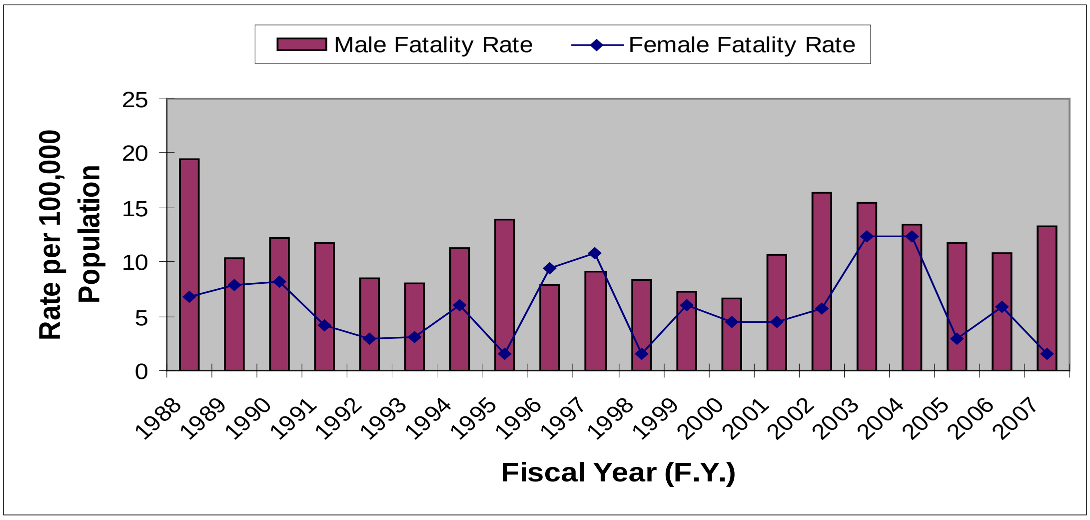

Figure 36. Fatality Rate per 100,000 Military Personnel by USAF Gender

(ii) suffered PT or P Dis in an MVC as a driver was 0.0004% to 0.0023% higher than the probability of a given USAF female member having suffered PT or P Dis in an MVC as a driver

(iii) experienced Lost Time Case in an MVC as a driver was almost identical to the probability of a given USAF female member having experienced Lost Time Case in an MVC as a driver

(iv) sustained a Minor Injury in an MVC as a driver was almost the same as the probability for a given USAF female member having sustained a Minor Injury in an MVC as a driver.

Type of Injury and Age Groups – Rank.

The results of the analysis did not provide strong evidence to support that the Type of Injury and the Age Group or the Type of Injury and the Rank of the USAF military personnel are statistically dependent at $\alpha = 0.01$.

However, some additional hypothesis tests were conducted in order to check if there is any tendency for either Age or Rank Group to correlate to a specific Type of Injury.

Figure 37 displays the CI Plots for the probabilities of Fatal and PT or P Dis MVCs per Age Group, at the 99% confidence level.

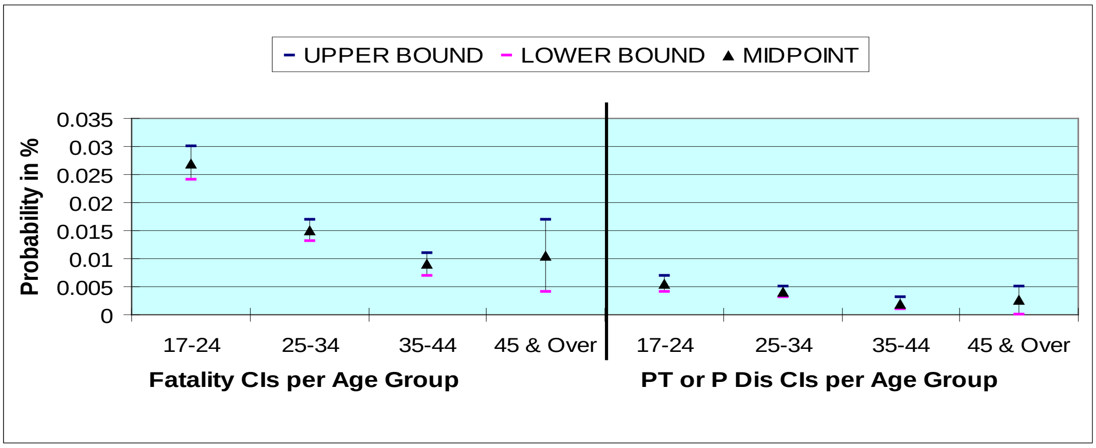

Figure 37. Confidence Interval Plots for the Fatal and PT or P Dis MVC Probabilities per Age Group

Also, figure 38 gives the pictorial comparison among USAF Age Groups fatality rates per 100,000 USAF population from F.Y. 1994 through F.Y. 2007.

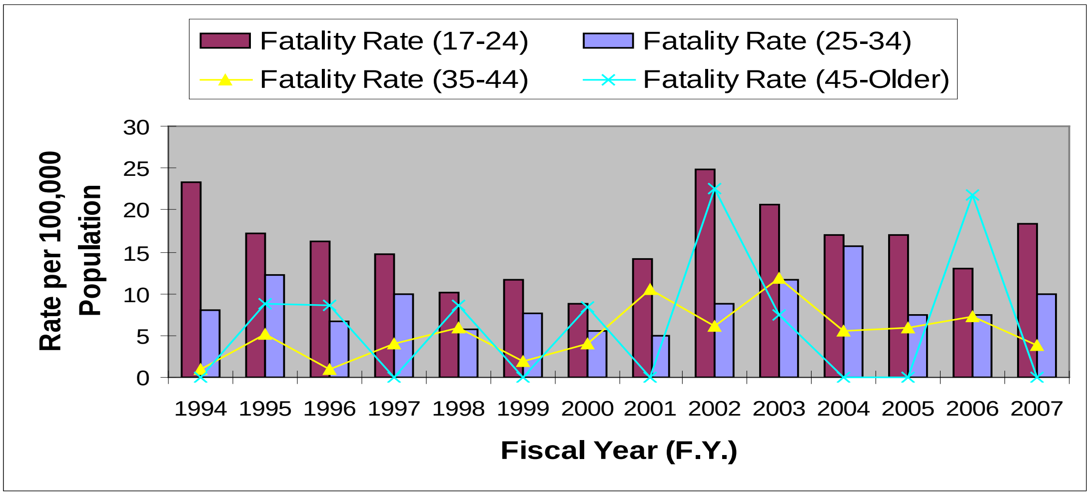

Figure 38. Fatality Rate per 100,000 Military Personnel by USAF Age Groups

In addition, figure 39 demonstrates the CI Plots for the probabilities of Lost Time Case and Minor Injury MVCs per Age Group, at the 99% confidence level.

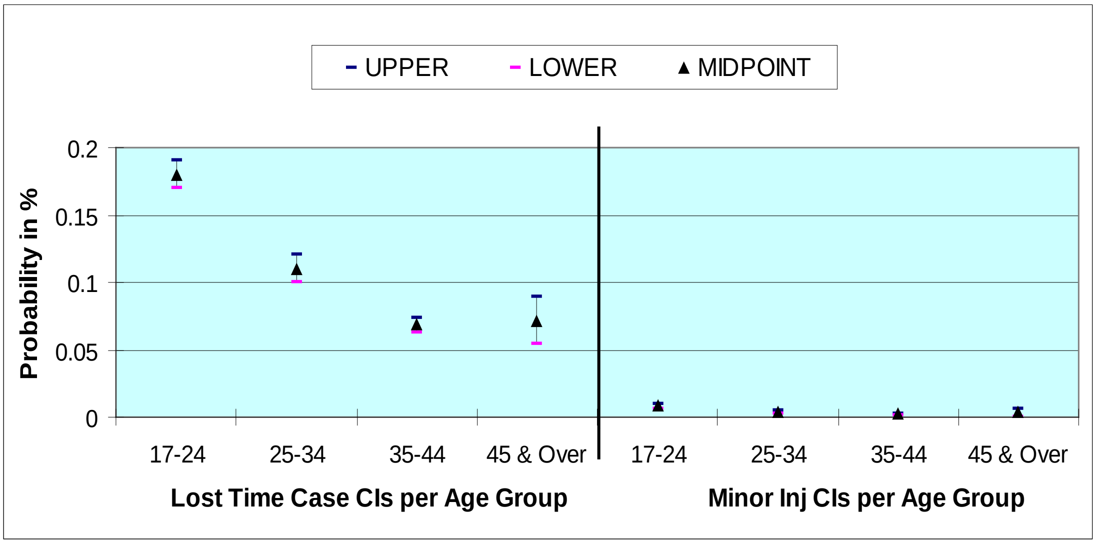

Figure 39. Confidence Interval Plots for the Lost Time Case and Minor Inj MVC Probabilities per Age Group

Likewise, figure 40 describes the CI Plots for the probabilities of Fatal and PT or P Dis MVCs per Rank Group, at the 99% confidence level.

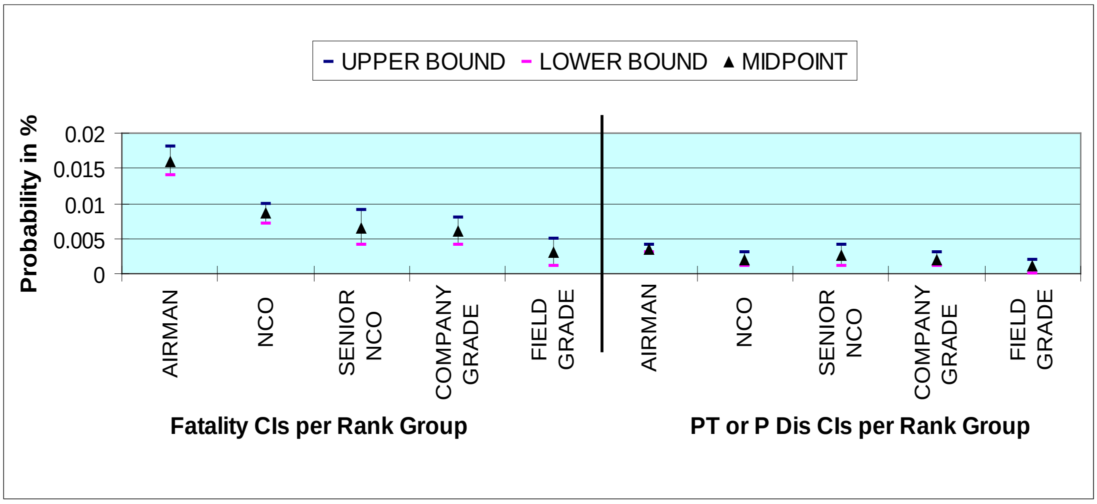

Figure 40. Confidence Interval Plots for the Fatal and PT or P Dis MVC Probabilities per Rank Group

Also, figure 41 shows the USAF Rank fatality rates per 100,000 USAF population from F.Y. 1988 through F.Y. 2007.

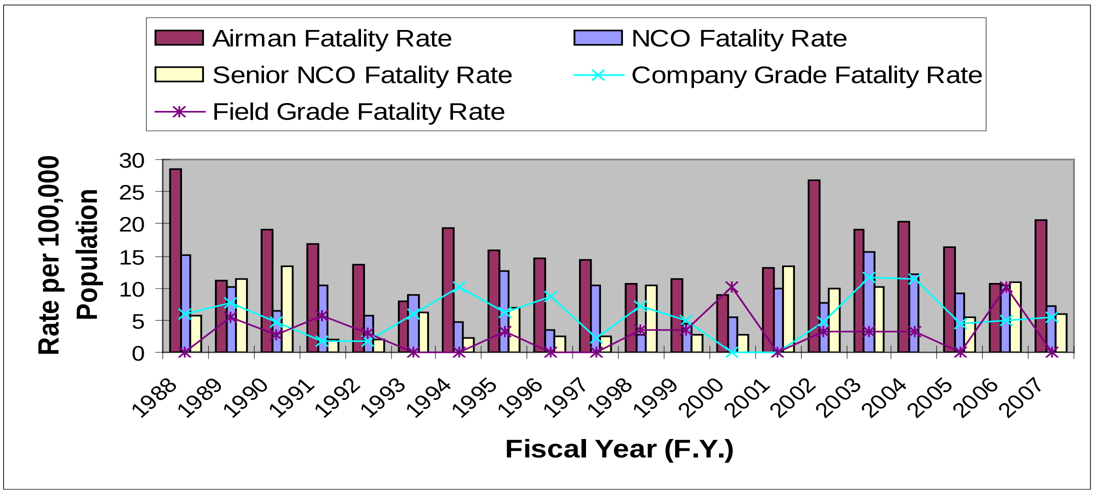

Figure 41. Fatality Rate per 100,000 Military Personnel by USAF Rank

Moreover, figure 42 depicts the CI Plots for the probabilities of Lost Time Case and Minor Injury MVCs per Rank Group, at the 99% confidence level.

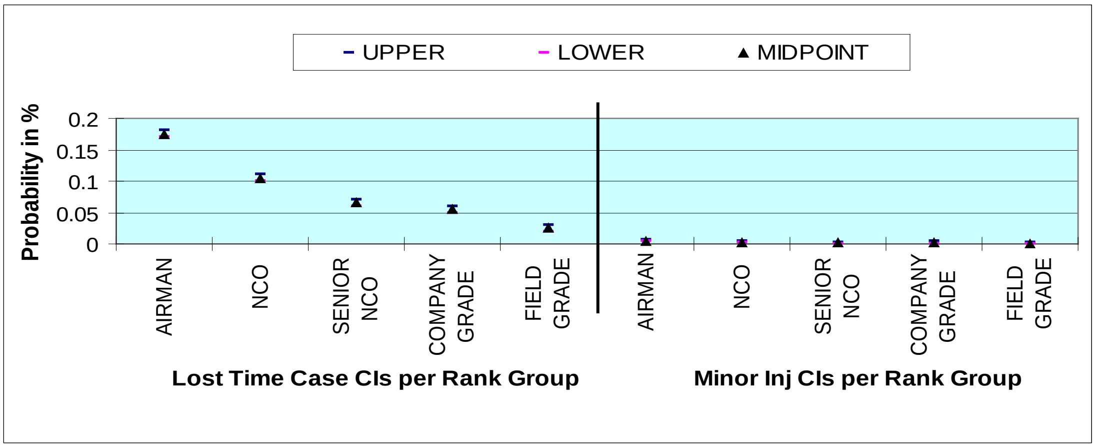

Figure 42. Confidence Interval Plots for the Lost Time Case and Minor Inj MVC Probabilities per Rank Group

6. Whether the Type of Injury is influenced by the Time of Day.

The outcomes of this analysis revealed strong evidence to suggest that the Type of Injury and the Time of Day are statistically dependent.

Furthermore, table 12 reveals the pair wise comparisons for the proportions' CIs of Fatal MVCs related to the Time of Day, at the 99% confidence level.

Table 12. Pair Wise Comparisons for the Proportions' Confidence Intervals of Fatal MVCs among the Time of Day Periods

TIME OF DAY	0200-0559	0600-0959	1000-1359	1400-1759	1800-2159	2200-0159
0200-0559		> (1.90% - 12.49%)	> (3.80% - 14.06%)	> (4.54% - 14.36%)	> (3.39% - 13.50%)	≈
0600-0959	< (1.90% - 12.49%)		≈	≈	≈	< (0.055% - 8.62%)
1000-1359	< (3.80% - 14.06%)	≈		≈	≈	< (2.00% - 10.16%)
1400-1759	< (4.54% - 14.36%)	≈	≈		≈	< (2.80% - 10.40%)
1800-2159	< (3.39% - 13.50%)	≈	≈	≈		< (1.61% - 9.57%)
2200-0159	≈	> (0.055% - 8.62%)	> (2.00% - 10.16%)	> (2.80% - 10.40%)	> (1.61% - 9.57%)	

Figure 43 maps the contrast among the Time of Day fatality percentages (%) from F.Y. 1997 through F.Y. 2007.

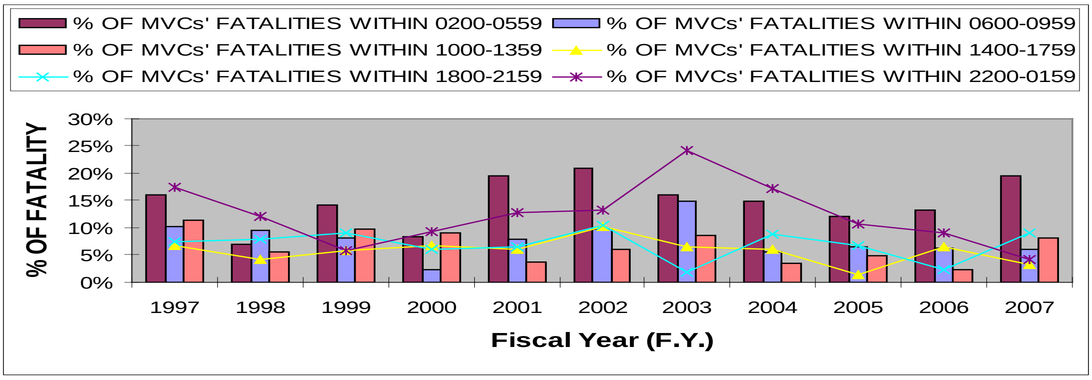

Figure 43. Fatality Percentages Comparison among the Time of Day Periods

In addition, this thesis is 99% confident that the proportion of USAF members who suffered PT or P Dis in MVCs was almost the same, independently of the Time of Day of the MVC occurrence.

Moreover, table 13 presents the pair wise comparisons for the proportions' CIs of Lost Time Case MVCs related to the Time of Day, at the 99% confidence level.

Table 13. Pair Wise Comparisons for the Proportions' Confidence Intervals of Lost Time Case MVCs among the Time of Day Periods

TIME OF DAY	0200-0559	0600-0959	1000-1359	1400-1759	1800-2159	2200-0159
0200-0559		< (5.09% - 17.83%)	< (7.01% - 19.46%)	< (7.44% - 19.33%)	< (5.32% - 17.63%)	≈
0600-0959	> (5.09% - 17.83%)		≈	≈	≈	> (2.54% - 13.10%)
1000-1359	> (7.01% - 19.46%)	≈		≈	≈	> (4.50% - 14.69%)
1400-1759	> (7.44% - 19.33%)	≈	≈		≈	> (4.99% - 14.50%)
1800-2159	> (5.32% - 17.63%)	≈	≈	≈		> (2.83% - 12.85%)
2200-0159	≈	< (2.54% - 13.10%)	< (4.50% - 14.69%)	< (4.99% - 14.50%)	< (2.83% - 12.85%)	

Finally, this study suggests with 99% confidence that the proportion of USAF members who sustained Minor Injuries in MVCs was almost the same, independently of the Time of Day of the MVC occurrence.

7. Whether the Type of Injury is affected by the Type of Vehicle that USAF military personnel use either as drivers or passengers.

Type of Injury and Type of Vehicle (USAF Drivers).

The results of the analysis provided evidence which suggests that the Type of Injury and the Type of Vehicle that the USAF military personnel drivers use are statistically dependent.

Additionally, this thesis supports with 99% confidence the assertion that, given that USAF members were in MVCs as drivers, the proportion of USAF members who:

(i) died was almost the same regardless of whether the members were driving 4W or 2W vehicles.

Figure 44 describes the driver fatality percentages (%) by Type of Vehicle from F.Y. 1988 through F.Y. 2007.

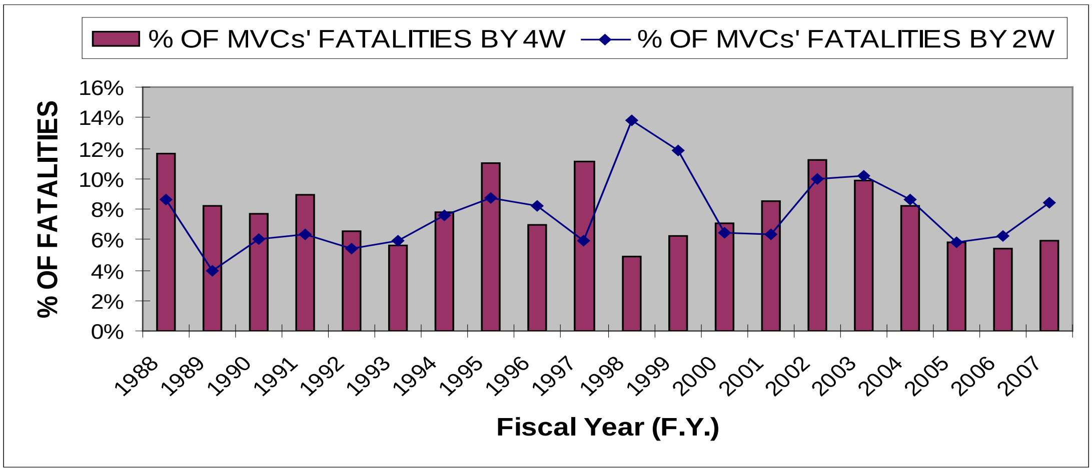

Figure 44. Driver Fatality Percentages Comparison between the Types of Vehicle

(ii) suffered PT or P Dis was 0.09% to 1.57% higher if the members were driving 2W rather than 4W vehicles

(iii) experienced Lost Time Case was almost the same, independently of whether the members were driving 4W or 2W vehicles

(iv) suffered Minor Injury was 1.17% to 2.48% higher if the members were driving 4W rather than 2W vehicles.

Type of Injury and Type of Vehicle (USAF Passengers).

The results of the analysis provided evidence to suggest that the Type of Injury and the Type of Vehicle in which USAF military personnel ride as passengers are statistically dependent.

Furthermore, this research supports with 99% confidence that, given USAF members were in MVCs as passengers, the proportion of USAF members who:

(i) died was almost the same, independently of whether the members were passengers in/on 4W or 2W vehicles.

Figure 45 provides a picture of the passenger fatality percentages (%) by Type of the Vehicle.

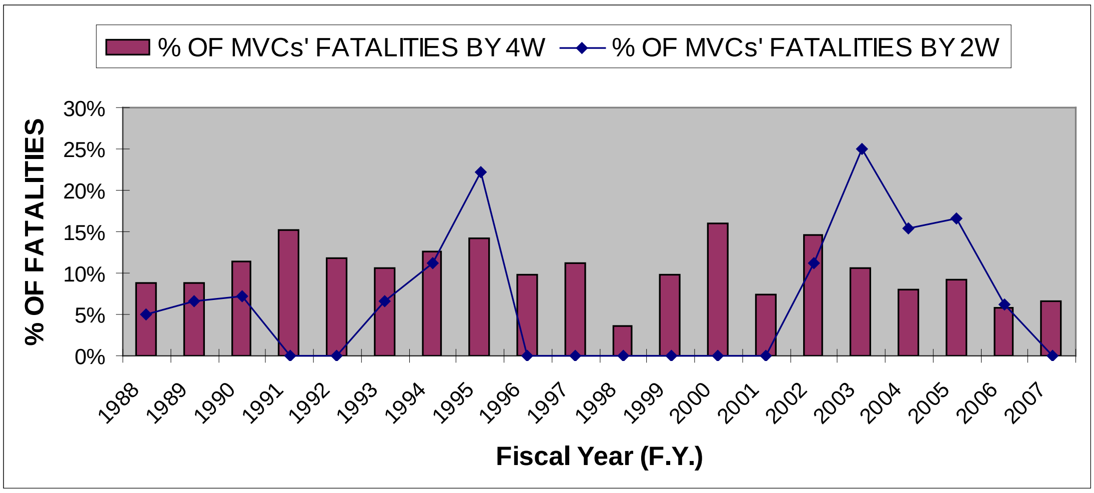

Figure 45. Passenger Fatality Percentages Comparison between the Types of Vehicle

(ii) suffered PT or P Dis was almost the same, independently of whether the members were passengers in/on 4W or 2W vehicles

(iii) experienced Lost Time Case was almost the same, independently of whether the members were passengers in 4W or 2W vehicles

(iv) suffered Minor Injury was 0.001% to 0.46% higher if the members were passengers in/on 4W rather than 2W vehicles.

8. Whether the Seatbelt factor (usage vs non usage by USAF military personnel involved in MVCs as either drivers or passengers) is associated with the Type of Injury.

Type of Injury and Seatbelt (USAF Drivers).

The results of the analysis provided strong evidence to conclude that the Type of Injury and Seatbelt factor are statistically dependent as regards USAF drivers.

This thesis states with 99% confidence that, given USAF members were in MVCs as drivers, the proportion of USAF members who:

(i) died was 18.15% to 25.98% higher if the members were not utilizing their seatbelts as contrasted with those who used seatbelts.

Figure 46 depicts the Seatbelt fatality percentages (%) from F.Y. 1988 through F.Y. 2007 in MVCs in which the USAF military personnel were involved as drivers.

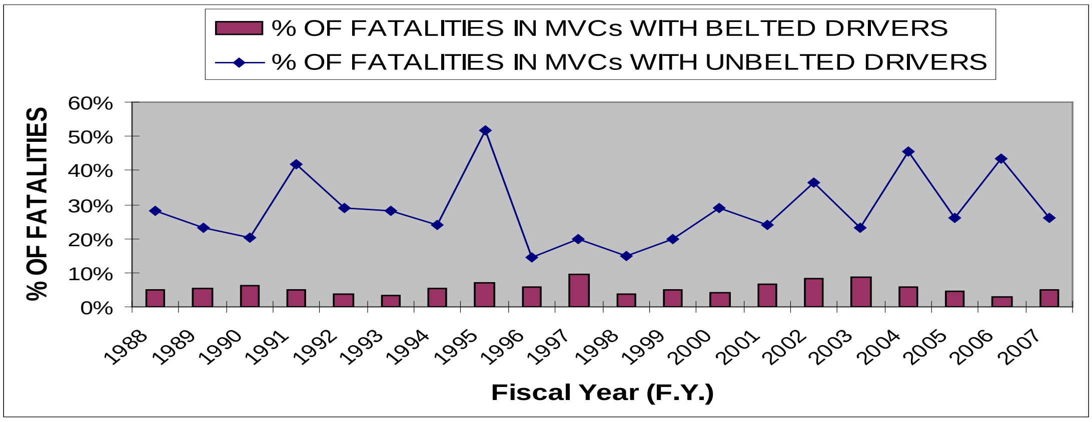

Figure 46. Belted vs. Unbelted Drivers in Case of Fatal MVCs

(ii) suffered PT or P Dis was 1.59% to 5.22% greater if the members were unbelted rather than belted drivers

(iii) experienced Lost Time Case was 20.52% to 28.89% higher if the members were belted rather than unbelted drivers

(iv) sustained Minor Injury was almost the same for unbelted and belted drivers.

Type of Injury and Seatbelt (USAF Passengers).

The results of the analysis provided strong evidence to support that the Type of Injury and Seatbelt factor are statistically dependent in cases concerning USAF passengers.

This thesis states with 99% confidence that, given that USAF members were in MVCs as passengers, the proportion of USAF members who:

(i) died was 8.79% to 18.15% higher if the members were unbelted rather than belted passengers.

Figure 47 portrays the Seatbelt fatality percentages (%) from F.Y. 1988 through F.Y. 2007 in MVCs in which USAF military personnel were involved as passengers.

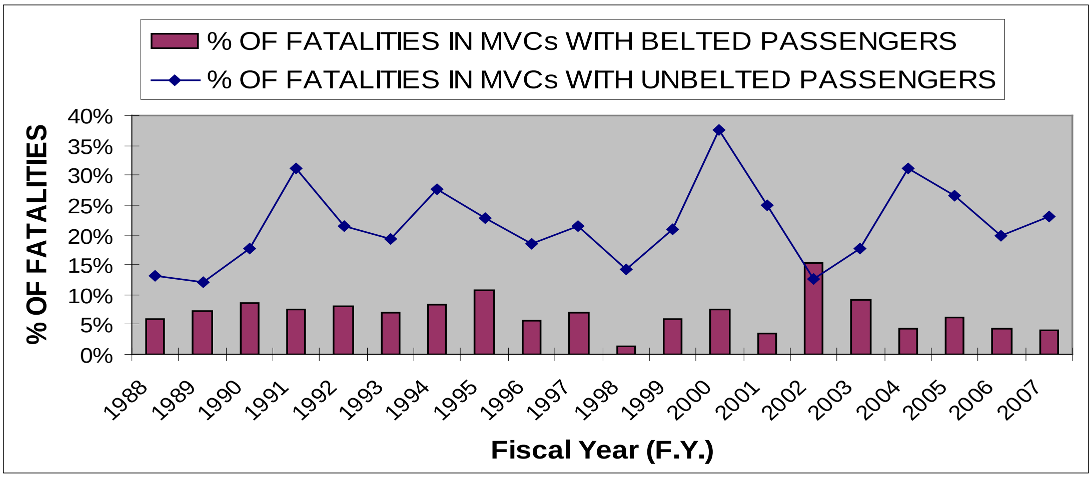

Figure 47. Belted vs. Unbelted Passengers in Case of Fatal MVCs

(ii) suffered PT or P Dis was almost the same for unbelted and belted passengers

(iii) experienced Lost Time Case was 7.49% to 18.29% higher if the members were belted rather than unbelted passengers

(iv) sustained Minor Injury was almost the same for unbelted and belted passengers.

9. Whether the seatbelt is associated with gender, age and rank of USAF military personnel, when an MVC event occurred.

The results of the analysis provided strong evidence to deduce that Seatbelt and Gender, Seatbelt and Age Groups and Seatbelt and Rank of USAF military personnel are statistically dependent.

This thesis asserts with 99% confidence that the proportion of USAF female belted drivers in MVCs, was 6.41% to 10.05% higher than that of USAF male belted drivers.

Figure 48 gives a picture of the contrast between USAF male and female seatbelt usage from F.Y. 1988 through F.Y. 2007. The USAF females display a propensity to wear seatbelts more than do USAF males.

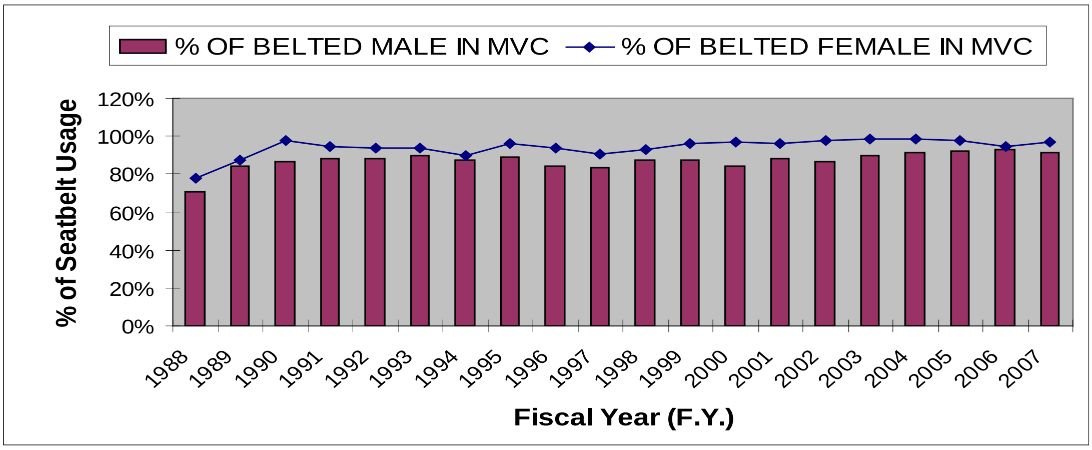

Figure 48. Seatbelt Usage Percentages by USAF Gender

Regarding the Seatbelt and Age Group of USAF military personnel, table 14 portrays the pair wise comparisons for the proportions' CIs of belted drivers in MVCs related to Age Groups, at the 99% confidence level.

Table 14. Pair Wise Comparisons for the Proportions' Confidence Intervals of Belted Drivers in MVCs among Age Groups

AGE GROUPS	17-24	25-34	35-44	45 & Over
17-24		< (1.25% - 6.32%)	< (0.61% - 7.28%)	< (0.21% - 13.45%)
25-34	> (1.25% - 6.32%)		≈	≈
35-44	> (0.61% - 7.28%)	≈		≈
45 & Over	> (0.21% - 13.45%)	≈	≈	

Furthermore, figure 49 illustrates the comparison among the USAF Age Groups seatbelt usage from F.Y. 1988 through F.Y. 2007.

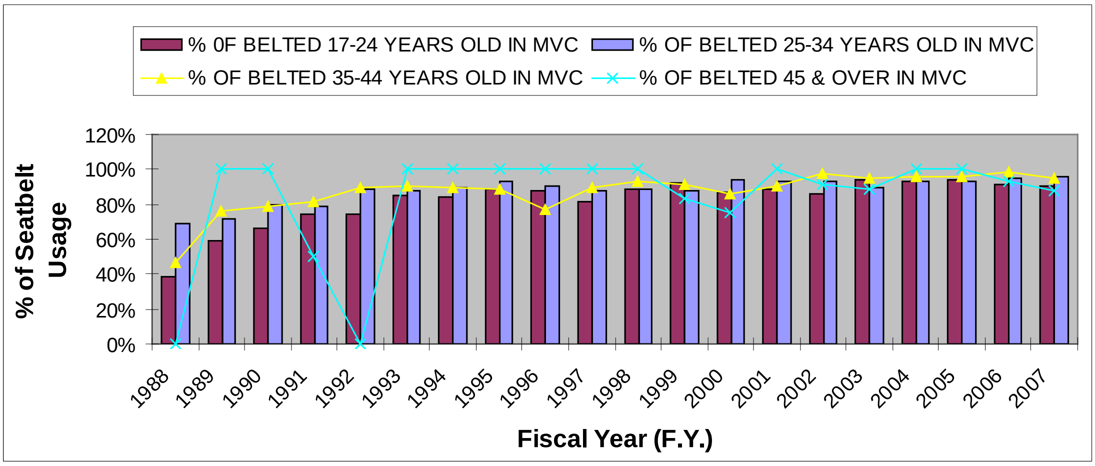

Figure 49. Seatbelt Usage Percentages by USAF Age Groups

Finally, concerning the Seatbelt and Rank of USAF military personnel, table 15 presents the pair wise comparisons for the proportions' CIs of belted drivers in MVCs related to Rank Groups, at the 99% confidence level.

Table 15. Pair Wise Comparisons for the Proportions' Confidence Intervals of Belted Drivers in MVCs among Rank Groups

RANK GROUPS	AIRMAN	NCO	SENIOR NCO	COMPANY GRADE	FIELD GRADE
AIRMAN		< (2.72% - 6.88%)	≈	< (4.71% - 11.10%)	≈
NCO	> (2.72% - 6.88%)		≈	≈	≈
SENIOR NCO	≈	≈		< (0.79% - 11.05%)	≈
COMPANY GRADE	> (4.71% - 11.10%)	≈	> (0.79% - 11.05%)		≈
FIELD GRADE	≈	≈	≈	≈	

Lastly, figure 50 provides the pictorial comparison for USAF Rank seatbelt usage from F.Y. 1988 through F.Y. 2007.

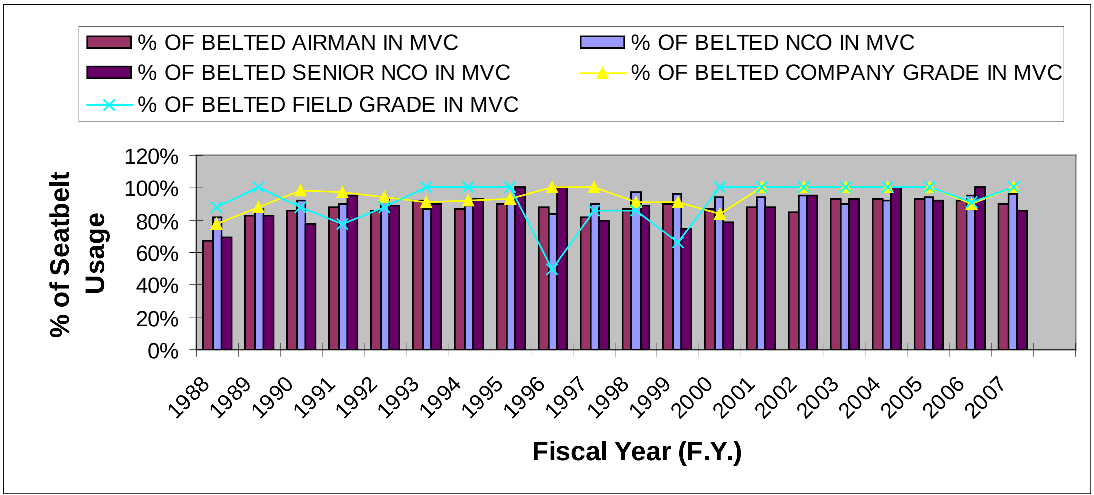

Figure 50. Seatbelt Usage Percentages by USAF Rank

Results of the ANOVA

2nd Policy Objective.

As this thesis stated in Chapters I and III, one of the primary policy objectives of this research effort was to identify the factors that are associated with alcohol consumption before driving and which affect the number of lost workdays resulting from MVCs and influence the total MVC direct costs and USAF budgets. As described in Chapter III, this thesis applied Analysis of Variance (ANOVA) to each of the following two research questions.

1. What factors are related to alcohol consumption for those MVCs for which there was a toxicological (TOX) test?

Alcohol Consumption ANOVA Model Outcomes.

This thesis has to point out that the following statistical inferences pertain to MVCs in which USAF military personnel were involved as drivers. In order to approach the above question, this study applied Analysis of Variance (ANOVA) with the BAC as the response variable. The factors of the model and their levels have been described in Chapter III. The ANOVA results using Minitab are presented in Table 16.

Table 16. BAC ANOVA Model Results

Response Variable: Blood Alcohol Concentration (BAC)						
Source	**DF**	**Seq SS**	**Adj SS**	**Adj MS**	**F**	**P-value**
DAYT	5	0.126394	0.127124	0.025425	5.05	0.000
RANK	4	0.110370	0.119063	0.029766	5.91	0.000
SEATB	2	0.122177	0.122177	0.061089	12.14	0.000
Error	648	3.260939	3.260939	0.005032		
Total	659	3.619879				
S = 0.0709388 R-Sq = 9.92% R-Sq (adj) = 8.39%						

Finally, the results of the analysis provided evidence to conclude that none of the interactions of the above factors is statistically significant not only at $\alpha=0.01$ but also at $\alpha=0.10$. Figure 51 demonstrates the salient effects of the factors to the response variable.

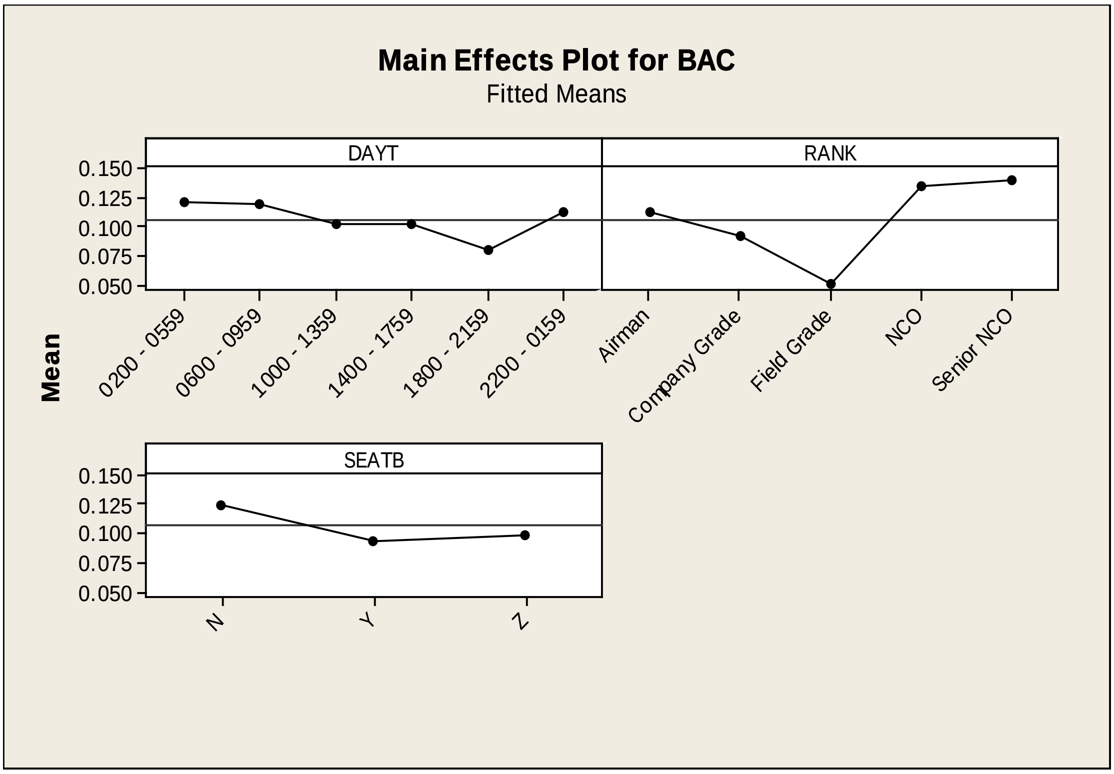

Figure 51. Main Effects Graph (BAC ANOVA Model)

Multiple Comparisons (BAC ANOVA Model).

A pair wise comparison analysis revealed evidence to deduce the following inferences by factor:

A) Time of Day.

USAF drivers involved in crashes between:

(i) 0200 to 0559 had a significantly higher BAC than did USAF drivers involved in crashes between 1800 and 2159 at α=0.01 level of significance

(ii) 0600 to 0959 had a significantly higher BAC than did USAF drivers involved in crashes between 1800 and 2159 at α=0.05 level of significance

(iii) 2200 to 0159 had a significantly higher BAC than did USAF drivers involved in crashes between 1800 and 2159 at α=0.01 level of significance.

(iv) No other pair was significantly different.

B) Rank.

USAF drivers with the rank of:

(i) NCO had a significantly higher BAC than did USAF drivers with the rank of Airman at α=0.01 level of significance

(ii) NCO had a significantly higher BAC than did USAF drivers with the rank of Company Grade at α=0.05 level of significance

(iii) Senior NCO had a significantly higher BAC than did USAF drivers with the rank of Company Grade at α=0.05 level of significance

(iv) No other pair was significantly different.

C) Seatbelt Usage.

USAF drivers who did not wear seatbelts had a significantly higher BAC, not only than did USAF drivers who did wear a seatbelt, but also higher than did 2W USAF drivers at α = 0.01 level of significance.

2. What factors influence the number of lost workdays resulting from MVCs in which USAF military personnel were involved?

In order to approach the above question, this thesis applied ANOVA. The Lost Days resulting from MVCs in which USAF military members were involved, either as drivers or passengers, is considered to be the response variable. The Time of Day, Gender, Rank, Age, Activity, Injury Groups, BAC, and Seatbelt are the factors of the model with their levels as described in Chapter III. In the following paragraphs this study will present the outcomes of its analysis by scenario.

1st ANOVA Model Outcomes.

Table 17 presents the most statistically significant factors and their interactions that affect the Lost Days for the 1st scenario.

Table 17. 1st ANOVA Model Results for the Lost Days

Response Variable: Log(Lost Days)						
Source	**DF**	**Seq SS**	**Adj SS**	**Adj MS**	**F**	**P-value**
DAYT	5	239.88	13.13	2.63	16.03	0.000
GEN	1	135.99	0.34	0.34	2.07	0.151
RANK	4	94.00	49.18	12.29	75.05	0.000
ACT	1	0.00	1.86	1.86	11.37	0.001
INJ	3	5,390.07	208.18	69.39	423.58	0.000
BAC	2	6.90	3.71	1.86	11.33	0.000
SEATB	2	88.86	6.66	3.33	20.33	0.000
GEN*SEATB	2	3.61	2.46	1.23	7.50	0.001
RANK*INJ	12	642.52	538.17	44.85	273.75	0.000
RANK*BAC	8	2.07	4.70	0.59	3.59	0.000
RANK*SEATB	8	9.22	8.77	1.10	6.69	0.000
INJ*BAC	6	10.26	8.05	1.34	8.19	0.000
INJ*SEATB	6	24.12	24.12	4.02	24.54	0.000
Error	8,249	1,351.38	1,351.38	0.16		
Total	8,309	7,998.88				
S = 0.404751 R-Sq = 83.11% R-Sq (adj) = 82.98%						

This study also will describe the results of Multiple Comparisons for the significant factors and their interactions at $\alpha = 0.01$ level of significance unless another level of significance is specified.

Main Effects (1st ANOVA Model).

Figure 52 demonstrates the main effects of factors on the response variable.

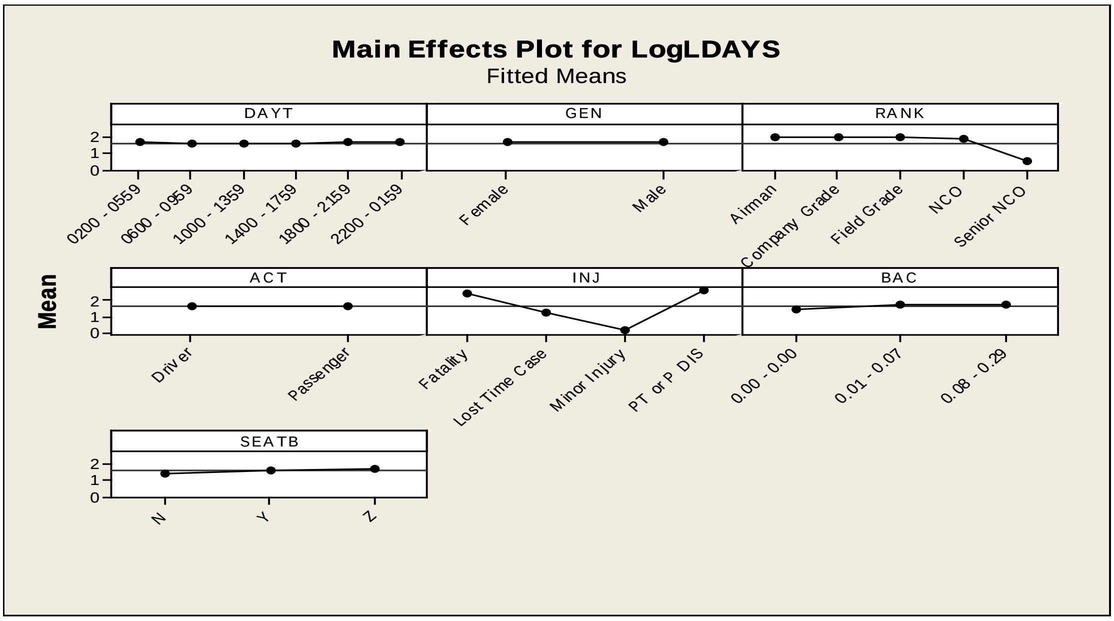

Figure 52. Main Effects Graph (1st ANOVA Model)

According to figure 52 and based on the pair wise comparison analysis, this study can make the following inferences:

A) Time of Day

This research supports the assertion that the MVCs which occurred in the two 4 hour groups from 2200 to 0559 resulted in a significantly higher number of Lost Days than the crashes that eventuated in the remaining four 4 hour groups from 0600 to 2159. No other pair is significantly different.

B) Gender

This thesis model does not provide any strong evidence that may support the significant difference between USAF male and female drivers in terms of Lost Days. This study retains this factor in the model because its interaction with the Seatbelt factor is statistically significant.

C) Rank

The results of the analysis indicate that USAF members with the rank of Senior NCO involved in MVCs caused a significantly lower number of Lost Days compared to any other rank groups. No other pair is significantly different.

D) Activity

This research asserts that USAF military members involved in MVCs as passengers incurred a significantly higher number of Lost Days than those who were involved in MVCs as drivers.

E) Type of Injury

The results of the analysis provided evidence that supports the assertion that the largest number of Lost Days was caused by the USAF members who sustained:

(i) PT or P Dis injuries, rather than fatal injuries at α=0.05 level of significance

(ii) PT or P Dis and fatal injuries instead of either Lost Time Case or Minor Injuries

(iii) Lost Time Case rather than Minor Injuries.

F) BAC

The model suggests that USAF members who caused a significantly larger number of Lost Days had BAC equal to:

(i) 0.08 - 0.29 rather than 0.00

(ii) 0.01 - 0.07 rather than 0.00

(iii) No other pair is significantly different.

G) Seatbelt

This analysis shows that USAF members who incurred a significantly higher number of Lost Days were:

(i) occupants of 2W rather than belted or unbelted occupants of 4W vehicle and

(ii) belted rather than unbelted occupants of 4W vehicle.

Interactions (1st ANOVA Model).

Figure 53 demonstrates the most significant interaction effects of the factors on the response variable.

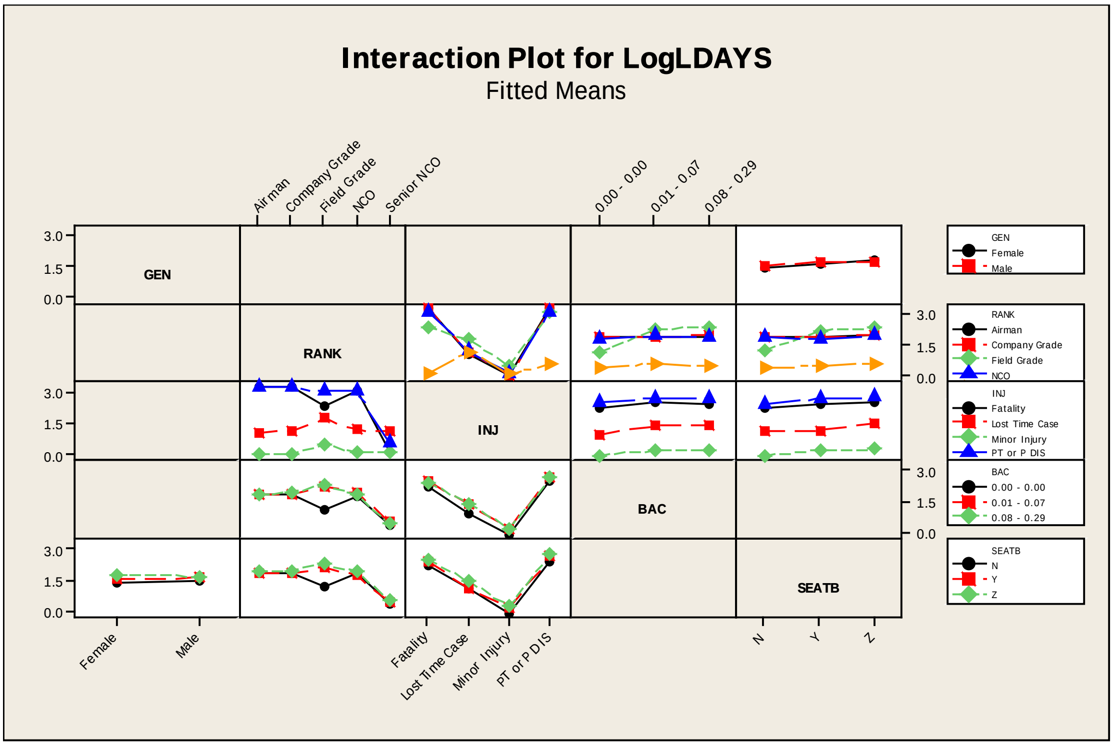

Figure 53. Interaction Graph (1st ANOVA Model)

Based on the figure 53 and the pair wise comparison analysis this study can make the following conclusions:

A) Gender and Seatbelt

Based on the Appendix C, this thesis can state that a significantly higher number of Lost Days are incurred by USAF:

(i) male or female occupants of 2W vehicles rather than females, either belted or unbelted, and male unbelted occupants in 4W vehicles

(ii) female occupants of 2W vehicles rather than male belted occupant in 4W vehicles at $\alpha=0.05$ level of significance

(iii) male or female belted occupants rather than female unbelted occupants

(iv) male belted occupants rather than female belted or male unbelted occupants

(v) No other pair is significantly different.

B) Rank and Type of Injury

According to the Appendix D, this thesis can state that a significantly higher number of Lost Days was incurred by MVCs which involved USAF military members with the rank of:

(i) Airman, Company Grade and NCO who experienced either fatal or PT or P Dis injuries rather than Airman, Company Grade, Field Grade, NCO and Senior NCO who incurred either Lost Time Case or Minor Injuries, or Field Grade and Senior NCO who experienced fatal injuries and Senior NCO who sustained PT or P Dis injuries

(ii) Field Grade who experienced either fatal or PT or P Dis injuries rather than Airman, Company Grade, Field Grade, NCO and Senior NCO who incurred either Lost Time Case or Minor Injuries and Senior NCO who experienced fatal or PT or P Dis injuries

(iii) Field Grade incurring Lost Time Case rather than Airman, Company Grade, NCO and Senior NCO who incurred either Lost Time Case or Minor Injuries or Field Grade who sustained Minor Injuries and Senior NCO who experienced either fatal or PT or P Dis injuries. However, the difference in terms of Lost Days between Field Grade incurred Lost Time Case and Company Grade, NCO and Senior NCO who suffered the same type of injury is significant at α=0.05 level of significance

(iv) Airman, Company Grade, NCO and Senior NCO who incurred Lost Time Case rather than Airman, Company Grade, NCO and Senior NCO who suffered Minor Injuries or Senior NCO who experienced either fatal or PT or P Dis injuries. However, the difference in terms of Lost Days between Airman, Company Grade who sustained Lost Time Case and Senior NCO who suffered PT or P Dis injuries is significant at α=0.05 level of significance

(v) the rank of Senior NCO who underwent PT or P Dis Injuries rather than Airman who suffered Minor Injuries or Senior NCO who experienced fatal injuries at α=0.05 level of significance

(vi) No other pair is significantly different.

C) Rank and BAC

Based on the Appendix E, this thesis can assert that a significantly higher number of Lost Days was incurred by those USAF military members with the rank of:

(i) Airman, Company Grade, NCO independently of their BAC levels and Field Grade with BAC equal to 0.01 - 0.07 and 0.08 - 0.29 rather than Field Grade with BAC equals to 0.00 or Senior NCO with any of the three BAC groups. However, the difference in terms of Lost Days between Company Grade with BAC equal to 0.01 - 0.07 and Field Grade with 0.00 BAC is significant at α=0.05 level of significance

(ii) Field Grade with 0.00 BAC rather than Senior NCO with BAC equal to 0.00 and 0.08 - 0.29

(iii) No other pair is significantly different.

D) Rank and Seatbelt

According to the Appendix F, this thesis can support the statement that a significantly higher number of Lost Days was incurred by those USAF military members who were:

(i) belted or unbelted occupants of 4W and occupants of 2W with the rank of Airman, Company Grade, Field Grade and NCO rather than belted or unbelted occupants of 4W and occupants of 2W with the rank of Senior NCO. However, the difference in terms of Lost Days between unbelted Field Grade occupants of 4W and occupants of 2W with the rank of Senior NCO is significant at $\alpha=0.05$ level of significance

(ii) unbelted occupants of 4W with the rank of Airman or NCO, belted occupants with the rank of Field Grade and occupants of 2W with the rank of Airman, Company Grade, Field Grade and NCO rather than unbelted occupants of 4W with the rank of Field Grade. However, the difference in terms of Lost Days between unbelted Airman and NCO and unbelted Field Grade is significant at $\alpha=0.05$ level of significance

(iii) occupants of 2W with the rank of Airman rather than belted Airman in 4W

(iv) occupants of 2W with the rank of NCO rather than belted NCO in 4W

(v) No other pair is significantly different.

E) Injury and BAC

Based on Appendix G, this thesis suggests that a significantly higher number of Lost Days was incurred by those USAF military members who experienced:

(i) either fatal or PT or P Dis injuries rather than Lost Time Case and Minor Injuries, independently of their BAC

(ii) PT or P Dis injuries with BAC equal either to 0.00 or 0.08 - 0.29 rather than fatal injuries with 0.00 BAC. However, the difference in terms of Lost Days between PT or P Dis with 0.00 BAC and fatal injuries with 0.00 BAC is significant at α=0.05 level of significance

(iii) Lost Time Case rather than Minor Injuries at any BAC level

(iv) Lost Time Case with BAC equals to 0.01 - 0.07 and 0.08 - 0.29 rather than Lost Time Case with BAC equal to 0.00

(v) No other pair is significantly different.

F) Injury and Seatbelt

According to the Appendix H, this thesis can claim that a significantly higher number of Lost Days was caused by those USAF military members who sustained:

(i) either fatal or PT or P Dis injuries rather than Lost Time Case and Minor Injuries, independently of whether they were belted or unbelted occupants of 4W vehicles or occupants of 2W vehicles

(ii) fatal injuries while they were either belted occupants in the 4W or occupants of 2W vehicles rather than fatal injuries while they were unbelted occupants in 4W vehicles

(iii) PT or P Dis injuries while they were either occupants of 2W vehicles or belted occupants of 4W vehicles rather than fatal injuries while they were unbelted occupants

(iv) PT or P Dis injuries while they were occupants of 2W vehicles rather than fatal injuries while they were belted occupants of 4W vehicles at $\alpha=0.05$ level of significance

(v) PT or P Dis injuries while they were occupants of 2W vehicle rather than PT or P Dis injuries while they were unbelted occupants at $\alpha=0.05$ level of significance

(vi) Lost Time Case rather than Minor Injuries independently of whether they were belted or unbelted occupants of 4W or occupants of 2W vehicle

(vii) Lost Time Case while they were occupants of 2W rather than Lost Time Case while they were belted or unbelted occupants in the 4W vehicle

(viii) Minor injuries while they were either belted occupants in the 4W or occupants of 2W vehicle rather than Minor injuries while they were unbelted occupants in the 4W vehicle at $\alpha=0.05$ level of significance

(ix) No other pair is significantly different.

2^{nd} ANOVA Model Outcomes.

Table 18 presents the most statistically significant factors and their interactions that affect the Lost Days for the 2^{nd} scenario.

Table 18. 2nd ANOVA Model Results for the Lost Days

Response Variable: Log(Lost Days)						
Source	**DF**	**Seq SS**	**Adj SS**	**Adj MS**	**F**	**P-value**
DAYT	5	89.129	12.167	2.433	15.52	0.000
GEN	1	85.631	0.203	0.203	1.30	0.255
AGE	4	9.210	7.438	1.859	11.86	0.000
ACT	1	1.312	1.173	1.173	7.48	0.006
INJ	3	1,815.484	216.533	72.178	460.23	0.000
BAC	2	4.834	0.433	0.217	1.38	0.251
SEATB	2	89.651	4.715	2.357	15.03	0.000
GEN*SEATB	2	3.378	2.725	1.362	8.69	0.000
INJ*BAC	6	12.920	10.553	1.759	11.21	0.000
INJ*SEATB	6	22.828	22.828	3.805	24.26	0.000
Error	8,041	1,261.055	1,261.055	0.157		
Total	8,073	3,395.432				
S = 0.396015 R-Sq = 62.86% R-Sq (adj) = 62.71%						

This study will also describe the results of the Multiple Comparisons for the significant factors and their interactions at $\alpha = 0.01$ level of significance unless another level of significance is specified.

Main Effects (2nd ANOVA Model).

Figure 54 displays the primary effects of the factors on the response variable.

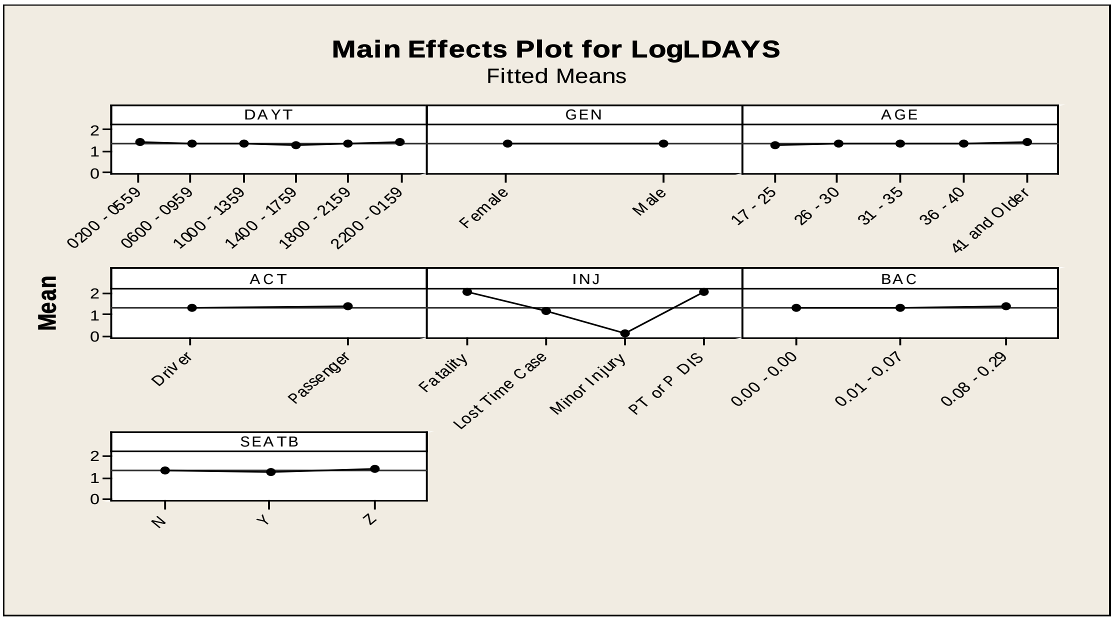

Figure 54. Main Effects Graph (2nd ANOVA Model)

According to the above figure, and based on the pair wise comparison analysis, this study can make the following inferences:

A) Time of the Day

This research supports that the MVCs which occurred in the two 4 hour groups from 2200 to 0559 resulted in a significantly higher number of Lost Days than did the crashes that eventuated in the remaining four 4 hour groups from 0600 to 2159. No other pair is significantly different.

B) Gender

This thesis model does not provide any strong evidence that may support any significant difference between USAF male and female drivers in terms of the Lost Days. This study retains this factor in the model because its interaction with the Seatbelt factor is statistically significant.

C) Age Groups

The results of the analysis indicate that the largest number of Lost Days were caused by the USAF members involved in MVC as occupants aged:

(i) 41 and over, rather than drivers aged 17 – 25, 26 – 30 and 31 – 35 years old

(ii) 41 and over, rather than drivers aged 36 – 40 years old at α=0.05 level of significance

(iii) 36 – 40 years old rather than drivers aged 17 – 25 years old at α=0.05 level of significance

(iv) No other pair is significantly different.

D) Activity

This research asserts that the USAF military members involved in MVCs as passengers caused a significantly higher number of Lost Days than those who were involved in MVCs as drivers.

E) Type of Injury

The results of the analysis provided evidence that supports the assertion that the largest number of Lost Days was caused by the USAF members who experienced:

(i) either fatal or PT or P Dis injuries rather than Lost Time Case or Minor Injuries

(ii) Lost Time Case rather than Minor Injuries

(iii) No other pair is significantly different.

F) BAC

This thesis model does not provide any strong evidence that supports any significant difference in BAC in terms of Lost Days. This study keeps this factor in the model because its interaction with the Type of Injury factor is statistically significant.

G) Seatbelt

This analysis shows that the the USAF members who caused a significantly higher number of Lost Days was:

(i) occupants of 2W rather than belted occupants of 4W vehicle and

(ii) occupants of 2W rather than unbelted occupants of 4W vehicle at α=0.05 level of significance.

(iii) No other pair is significantly different.

Interactions (2nd ANOVA Model).

Figure 55 demonstrates the most significant interaction effects of the factors on the response variable.

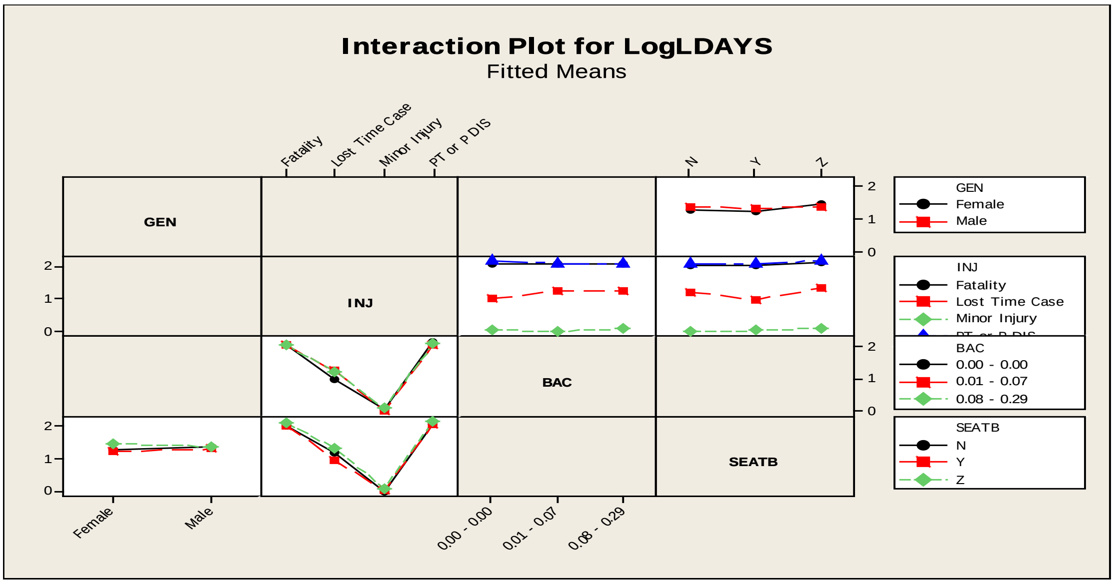

Figure 55. Interaction Graph (2nd ANOVA Model)

Based on the figure 55 and the pair wise comparison analysis this study can make the following conclusions:

A) Gender and Seatbelt

According to the Appendix I, this thesis can claim that a significantly higher number of Lost Days was caused by the USAF:

(i) male or female, occupants of 2W vehicle and male either belted or unbelted occupant of 4W vehicle rather than female belted occupant of 4W vehicle

(ii) female, occupant of 2W vehicle rather than male belted occupant of 4W vehicle

(iii) female, occupant of 2W vehicle rather than unbelted female occupant of 4W vehicle at α=0.05 level of significance

(iv) male, occupant of 2W vehicle rather than belted male occupant of 4W vehicle at α=0.05 level of significance

(v) No other pair is significantly different.

B) Type of Injury and BAC

Based on the Appendix J, this thesis can claim that a significantly higher number of Lost Days was caused by those USAF military members who experienced:

(i) either fatal or PT or P Dis injuries rather than Lost Time Case and Minor Injuries independently of their BAC levels

(ii) Lost Time Case rather than Minor Injuries independently of their BAC groups

(iii) Lost Time Case with BAC equal to 0.01 - 0.07 and 0.08 - 0.29 rather than Lost Time Case with BAC equal to 0.00

(iv) No other pair is significantly different.

C) Type of Injury and Seatbelt

Based on the Appendix K, this thesis can claim that a significantly higher number of Lost Days was caused by those USAF military members who sustained:

(i) either fatal or PT or P Dis injuries rather than Lost Time Case and Minor Injuries independently of whether they were belted or unbelted occupants of 4W or occupants of 2W vehicles

(ii) Lost Time Case rather than Minor Injuries independently of whether they were belted or unbelted occupants of 4W or occupants of 2W vehicles

(iii) Lost Time Case while they were occupants of 2W vehicles rather than Lost Time Case while they were belted or unbelted occupants in 4W vehicles

(iv) Lost Time Case while they were unbelted occupants of 4W vehicles rather than Lost Time Case while they were belted occupants in 4W vehicles

(v) No other pair is significantly different.

Summary

In this chapter, this thesis discussed the results of the categorical data analysis and ANOVA. This study explained its findings and answered the research questions set at Chapters I and III. This research will proceed to review these findings and implications in Chapter V, and provide recommendations for future research.

V. Conclusions and Recommendations

Review of Research Objectives

The objectives of this research were to identify the risk factors that are related to MVCs, influence the severity of injuries, are associated with the alcohol consumption, and affect the number of lost workdays resulting from MVCs. This study has tried to answer a number of exploratory questions which were established for a better analysis and understanding of the above objectives. In order for this thesis to accomplish its goals and to answer its research questions, Categorical Data Analysis and Analysis of Variance (ANOVA) have been utilized.

Overall Conclusions of Research

General Results

The results of this thesis attest to the fact that the Private Motor Vehicle Mishap (PMV) is one of the most serious problems that the USAF has to deal with and is one which requires more effective and intensive interventions. It is dispiriting but the current PMV Mishap rate per 100,000 USAF population is still high, remaining close to the corresponding rate in F.Y. 1988. There was a reduction of the fatality rate from F.Y. 2002 until F.Y. 2006. However, in 2007, the rate rose to 12.77 fatalities per 100,000 USAF population from the 2006 rate of 11.91. Finally, the results show that the current injury rate is still comparable to the higher levels of the F.Y. 1988 – 2007 period and unfortunately is almost identical to the 1988 injury rate.

Furthermore, the results of the categorical data analysis indicate that USAF members were more likely to be involved in MVCs as drivers rather than as passengers (assuming that non-injured passengers with non- military drivers were involved in MVCs and they have reported the incident) but the proportion of USAF passengers who died in MVCs is higher than that of USAF drivers while USAF members had the same proportion of suffering PT or P Dis either as drivers or passengers.

Categorical Data Analysis and BAC ANOVA Model Results - Limitations

This thesis believes that the majority of Categorical Data Analysis outcomes seem to be logical and consistent with this thesis literature review. However, some counterintuitive results were found through the above analysis and this thesis will try to explain them in this chapter. Due to the large number of investigative questions that this thesis has tried to answer in order to deal with its objectives, this study presents the results of the categorical data analysis and BAC ANOVA Model by factor.

Gender.

The results of this analysis revealed that there is no significant difference between USAF males and females in the aspect of any propensity to become involved in MVCs. However, USAF male drivers had a higher probability of either dying or sustaining a PT or P Dis than did USAF female drivers while both had the same probability of experiencing either Lost Time Case or Minor Injuries. Also, USAF female drivers seemed to wear seatbelts more than USAF male drivers. This might explain why male drivers suffered more severe injuries than those incurred by female drivers.

Age.

This research found that USAF military personnel aged 17-24 years were more prone to being involved in MVCs than any other age group. This age group also had the highest probability of being involved in a fatal MVC, followed by members of the 24-34 age group. The above figures are as anticipated and are consistent with this study's literature review since members of this age group drive more than any other and consequently have a higher level of exposure to road traffic risks. Finally, members aged 17-24 years involved in MVCs wore their seatbelts less than members of other age group in crashes.

Rank.

The results of the analysis suggested that the USAF members with the rank of Airman were more prone to experience an MVC than any other rank group. The above rank group also had the highest probability of involvement in a fatal MVC. Once again, the above results might be related with the young age of the Airman ranks and the reasons which were presented above under the age factor.

Furthermore, the rank of Company Grade tended to use their seatbelts more than those with the ranks of Airman and Senior NCO when involved in MVCs as drivers. Additionally, members of NCO rank are more likely to drive belted when involved in MVCs than are those with the rank of Airman. All other comparisons showed the same proportions of seatbelt usage while driving in MVCs.

Finally, the ANOVA results showed that rank was one of the most statistically significant factors that influence BAC levels. Based on the BAC ANOVA model, NCO followed by Senior NCO military members tended to be under the influence of alcohol more than the other rank groups when they were driving in MVCs.

Time of Day.

According to this study, the most risky time period of day for USAF military members to be involved in an MVC was between 1400 and 1759 pm. On the other hand, the fatal PMV mishaps peaked between the hours of 2200 pm to 0559 am, which encompasses most of the night period and likely related with drivers' propensity towards taking more risks during nighttime than daytime travel.

The factor of the Time of Day was also statistically significant in the BAC ANOVA model. The USAF military members who were involved in MVCs during the time from 2200 pm until 0559 am had a significantly higher BAC than those who were involved in MVCs between 1800 pm and 2159 pm. This last finding reinforces the above stated propensity of drivers towards taking more risks when driving at nighttime.

Type of Vehicle.

The Type of Vehicle involved in the majority of MVCs was the 4W vehicle rather than 2W vehicle. However, based on the AFSC data, both USAF drivers and passengers had the same proportions of experiencing fatal MVCs independently of whether they drove or used either a 4W or a 2W vehicle. This thesis believes that more data are needed to be collected concerning the Vehicle Traveled Miles (VTM) of each Type of Vehicle which the USAF members drive or use. This additional information might give a better measurement of the exposure level to road traffic risks by Type of Vehicle and more reliable findings may be drawn.

Alcohol Consumption in terms of BAC.

This research has to be very cautious with the interpretation of its BAC analysis outcomes in order to avoid making a selection bias error. The results of the analysis rely on only part of the AFSC data because TOX tests were not conducted for all of the MVCs in the data. It is well known that TOX tests were performed only in some incidents, most likely in those in which there were strong indications that the drivers had consumed alcohol before driving. The only conclusion that this thesis can claim concerning the BAC is that, given that TOX tests were conducted after MVC events, the proportion of BAC between 0.08 and 0.29 was higher than that for the other two BAC levels.

The circumstances described above might explain why factors such as Gender, Age Group and Type of Injury, which are commonly associated with drivers' alcohol consumption, did not seem to be statistically significant factors in the BAC ANOVA model.

Seatbelt.

Seatbelts, but more specifically the use or non use of this occupant protection system, had a significant effect on the Type of Injury. This thesis should highlight the value of wearing seatbelts for the prevention of severe injuries during crashes. Based on the AFSC data, both unbelted USAF drivers and similarly unrestrained passengers had significantly higher proportions experiencing fatal MVCs than those who were belted at the time of the MVC. Moreover, unbelted USAF drivers had a higher proportion of sustaining PT or P Dis MVCs than those who were belted at the time of the MVC. On the other hand, both belted USAF drivers and belted passengers had significantly higher proportions suffering Lost Time Case MVCs than those who were unbelted at the time of the MVC. The seatbelt factor was also statistically significant in the BAC ANOVA model. The USAF drivers of 4W vehicles who did not wear a seatbelt had a significantly higher BAC than did, not only those who did wear seatbelts in 4W vehicles but also 2W USAF drivers.

Lost Days ANOVA Results - Limitations

Regarding the ANOVA analysis for the Lost Days, this thesis applied two separate models for the reasons carefully detailed in Chapter III.

Both models have common significant main factors, which are the Time of Day, Activity, Type of Injury and Seatbelt. Moreover, the 1st ANOVA model has two additional main factors, Rank and BAC whereas the 2nd ANOVA model has Age Group.

In both models the night hours and more specifically the time period from 2200 pm to 0559 am have the greatest impact upon Lost Days of any Time of Day period. One possible explanation of this is that occupants tend to take more risks (they may drink more, increase speed, or not use safety equipment such as seatbelts or helmets, underestimate the increased risks of nighttime driving due to the reduced visibility, etc) during the nighttime in comparison with daytime travel.

This thesis can state that increased alcohol consumption and non-use of seatbelts do not correlate significantly to night hours, since the interaction factors of the Time of Day and BAC and Time of Day and Seatbelt were not statistically significant in either model. However, this thesis cannot reach a conclusion for the remaining risks due to the lack of this information within the data.

Rank was a statistically significant factor only for the 1st ANOVA model. More specifically, Senior NCOs seemed to be more resistant to MVCs and to incur fewer Lost Days than did any other rank group.

However, this thesis should be very cautious with this result. None of the ranks, which constitute the Senior NCO group, were included in the extrapolation table of the estimation of the Lost Days in fatal or PT or P Dis cases for the 1st scenario. This occurred because, based on the Time in Service Table, the above ranks had already exceeded the upper bound of 20 years of service (which is one of the assumptions of this extrapolation scenario which are presented in the Appendix B) ; hence, the Lost Days estimation for the above cases was zero for these ranks.

In the 2nd ANOVA model, Age seems to be a statistically more significant factor than is Rank. The military members aged 41 and over had a greater affect upon Lost Days rates than did any other age group. Also, there was a significant difference in terms of Lost Days between those members aged 36-40 years and those aged 17-25 years, with the older members causing greater Lost Days than the younger members. This may be related with longer recovery times being required for older people than younger age groups.

Additionally, in both ANOVA models, the Activity had a statistically significant effect on the Lost Days. This thesis analysis revealed that USAF military passengers had a more significant affect on Lost Days than did USAF military drivers.

The Type of Injury was a statistically significant factor in both models. This thesis has to point out that this factor has a strong effect on the number of Lost Days. Based on the analysis, it seems that the more severe the Type of Injury that is incurred, the greater the number of Lost Days that is recorded. More specifically, in both models the fatal and PT or P Dis injuries resulted in a significantly greater number of Lost Days than did the Lost Time Case or Minor Injuries. Finally, based on the 1st scenario results, the PT or P Dis injuries caused a significantly higher number of Lost Workdays than did those that were caused by fatal injuries.

Moreover, the BAC factor was statistically significant to the 1st model but not to the 2nd one. The ANOVA outcomes for the 1st model revealed that cases showing the presence of alcohol (either BAC = 0.01-0.07 or BAC = 0.08-0.29) caused a significantly greater number of Lost Days when compared to those with no presence of alcohol (BAC = 0.00) indicated.

Additionally, concerning the Seatbelt factor, both scenarios' results revealed that the USAF military occupants of 2W vehicles incurred a significantly higher number of Lost Days than did USAF military belted or unbelted occupants of 4W vehicles. The above result is reasonable given that 2W occupants do not have enough protection compared to the 4W occupants, relying mostly on their clothing and their personal readiness.

Surprisingly, the 1st ANOVA model results regarding the Seatbelt factor showed that the belted occupants incurred a significantly higher number of Lost Days than did the unbelted occupants in contrast with the 2nd scenario in which there is no significant difference in terms of Lost Days between belted and unbelted occupants. It might be possible that when people feel safe, they may be more inclined to behave less carefully than when feeling vulnerable or cautious.

It seems reasonable for this thesis to assume that seatbelt use can prevent many of severe or fatal injuries, but at the same time, the seatbelt use in combination with other factors such as excessive speed, can cause many other injuries on the human body if an MVC occurs. The above explanation is supported by this thesis' Categorical Data Analysis concerning the Seatbelt's results. Both unbelted USAF drivers and passengers had significantly higher proportions of fatal MVCs than did those who were belted at the time of the MVC. Moreover, unbelted USAF drivers had higher proportions of sustaining PT or P Dis MVCs than did those who were belted at the time of the MVC. In contrast, both belted USAF drivers and passengers had significantly higher proportions of suffering Lost Time Case MVCs (which represent almost 85% of cases in the AFSC data) than did those who were unbelted at the time of the MVC.

Finally, relating to the interaction factors, the 1st ANOVA model has three additional factors and three common factors compared to the 2nd one, which has only these three common interaction factors with the 1st ANOVA model. The interactions of Gender with Seatbelt, Injury with BAC and Injury with Seatbelt are the common interaction factors while the Rank with Injury, Rank with BAC and Rank with Seatbelt are the supplementary interaction factors in the 1st ANOVA model. This study analysis showed that the interpretation of the results differs interestingly and significantly even among the common interaction factors of the two ANOVA models. In Appendices C-K, this study presents a detailed description of the above interaction factors' interpretation. The basic common characteristics of these interpretations are the dominant roles of the Type of Injury and the 2W vehicle MVCs. Once again, the more severe the Type of Injury is, the greater the number of Lost Days becomes; the 2W vehicles MVCs have the most significant effect on the number of Lost Days.

This research considers the 1st model to be a more useful and more reliable model for use in making safety decisions for the following primary reason. The primary reason is that the 1st ANOVA model employed the 1st scenario for extrapolating the Lost Days in fatal and PT or P Dis MVC cases as this thesis comprehensively described in Chapter III and presented in Appendix B as well. Although, the 2nd scenario is more simple and easier to utilize, this research believes that the 1st scenario estimates more accurately the missing Lost Days in the above two injury cases since it takes into account realistic information e.g. the Retention Rate data per rank (AF/A1, 2008), the Time in Service and the Time in Grade (Office of Secretary of Defense, Information Delivery System, 2008). On the other hand, the more simplistic 2nd scenario relies only on the basic assumption of a fixed number of Lost Days associated with the average time that the AFPC needs to find and send someone new to take over the position from the previous member who had suffered a serious MVC.

Recommendations for Future Research

This thesis establishes the ground-work for future research. This study has been limited because the data used in this research are not complete. Factors such as speed and safety equipment other than seatbelts, for example helmets or airbags, were not addressed in the current analysis due to the lack of these factors in the present

AFSC data base. These could be added in the future. Inclusion of the speed factor in particular, will provide a better insight into these PMV mishaps, given that this factor is considered one of the critical factors in many MVC occurrences.

Another potential area for follow-up research would be to use the database and analysis of this study and apply it to:

(i) test statistically whether USAF safety intervention programs are making a difference in MVCs

(ii) find a better approach for dealing with the issue of the Lost Days extrapolation in MVCs in which USAF military members were involved and due to which they experienced either fatal or PT or P Dis injuries.

Appendix A. Definitions of Economic Costs

Medical Costs:

The cost of all medical treatment associated with motor vehicle injuries including that given during ambulance transport. Medical costs include emergency room and inpatient costs, follow-up visits, physical therapy, rehabilitation, prescriptions, prosthetic devices, and home modifications.

Emergency Services:

Police and fire department response costs.

Vocational Rehabilitation:

The cost of job or career retraining required as a result of disability caused by motor vehicle injuries

Market Productivity:

The present discounted value of the lost wages and benefits over the victim's remaining life span.

Household Productivity:

The present value of lost productive household activity, valued at the market price for hiring a person to accomplish the same tasks.

Insurance Administration:

The administrative costs associated with processing insurance claims resulting from motor vehicle crashes and defense attorney costs.

Workplace Costs:

The costs of workplace disruption that is due to the loss or absence of an employee. This includes the cost of retraining new employees, overtime required to accomplish work of the injured employee, and the administrative costs of processing personnel changes.

Legal Costs:

The legal fees and court costs associated with civil litigation resulting from traffic crashes.

Travel Delay:

The value of travel time delay for persons who are not involved in traffic crashes, but who are delayed in the resulting traffic congestion from these crashes.

Property Damage:

The value of vehicles, cargo, roadways and other items are damaged in traffic crashes.

(NHTSA, 2002; 809-446: 73-74).

Appendix B: Two Scenarios of Extrapolating the Lost Days for the Fatal and PT or P Dis Injuries

1st Scenario

Lost Work Days equal to the 20-year retirement point minus the Time in Service (TiS) of the military member, taking into account the Retention Rate by Grade

This thesis assumes that:

(i) The Upper Limit for Active Service for the USAF member is 20 Years (minimum retirement point).

(ii) The TiS per rank for each death and PT or P Dis personnel is the average TiS based on the 5 last years (FY 2003 - FY 2007) TiS data (Office of Secretary of Defense, Information Delivery System, 2008).

(iii) The Time in Grade (TiG) for each death and PT or P Dis personnel is the average TiG based on the 5 last years (FY 2003 - FY 2007) TiG data (Office of Secretary of Defense, Information Delivery System, 2008).

(iv) The exact number of years that the death and PT or P Dis personnel held their rank at the time of the MVC is the midpoint of the average TiG. The purpose of this midpoint calculation is to estimate the remaining years that the members should stay at the same rank before their anticipated promotion date.

(v) The Retention Rate per rank for each death and PT or P Dis personnel is the average Retention Rate based on the 5 last years (FY 2004 - FY 2008) Retention Rate data (AF/A1, 2008).

(vi) The number of work days per year is 220 days.

The formula which this study applied in order to make the lost work days estimation for this scenario is:

$$\text{Expected No of Lost Work Days} = 220 * \sum_{i=1} p_{i,r}$$

where $p_{i,r}$ is the probability that the death or PT or P Dis military member would be in service after i years, taking into consideration the average Retention Rate by Rank, r. For example (the numbers are randomly selected):

A male Major with 14 years as TiS experienced a fatal injury due to an MVC. He could have been in service 6 years more before he would have reached the minimum retirement point at 20 years of service. Also, this thesis assumes that:

(i) he could have been Major for the next 3 years (based on the midpoint estimation) from the point of the MVC until his promotion to Lt Col

(ii) he could have been Lt Col for 3 years (based on the TiG table) from the point of his promotion to Lt Col until his retirement.

Table 19 depicts the process that this thesis employed in order to calculate the Lost Days for the above example using the retention rates by grade.

Table 19. Lost Days Calculation Process

YEAR	15 (or the 1st Year after the MVC)	16 (or the 2nd Year after the MVC)	17 (or the 3rd Year after the MVC)	18 (or the 4th Year after the MVC)	19 (or the 5th Year after the MVC)	20 (or the 6th Year after the MVC)	PROBABILITY (Retention Rate)
RANK	MAJOR			LT COL			
Major with 14 Years as Time in Service Experienced a Fatal Injury due to an MVC	P_{maj}						P_{maj}
	P_{maj}	P_{maj}					(P_{maj})^2
	P_{maj}	P_{maj}	P_{maj}				(P_{maj})^3
	P_{maj}	P_{maj}	P_{maj}	$P_{Lt\ Col}$			(P_{maj})^3 * $(P_{Lt\ Col})$
	P_{maj}	P_{maj}	P_{maj}	$P_{Lt\ Col}$	$P_{Lt\ Col}$		(P_{maj})^3 * $(P_{Lt\ Col})$^2
	P_{maj}	P_{maj}	P_{maj}	$P_{Lt\ Col}$	$P_{Lt\ Col}$	$P_{Lt\ Col}$	(P_{maj})^3 * $(P_{Lt\ Col})$^3

A detailed description of this process follows.

Using the above formula and the steps from the above table, this study can estimate the expected number of lost workdays for this example by calculating:

$$p_1 = p_{maj} = 0.91,$$

where p_{maj} is the probability (retention rate) of his staying in service after the 1st year of the MVC if he had survived the MVC and in the same way for the 2nd year:

$$p_2 = (p_{maj})^2 = (0.91)^2 = 0.83$$

where $(p_{maj})^2$ is the probability (retention rate) of his staying in service after the 2nd year of the MVC as a Major if he had survived the MVC and in the same way for the 3rd year:

$$p_3 = (p_{maj})^3 = (0.91)^3 = 0.75$$

where $(p_{maj})^3$ is the probability (retention rate) of his staying in service after the 3rd year of the MVC as a Major if he had survived the MVC and in the same way for the 4th year:

$$p_4 = (p_{maj})^3 * p_{Lt\ Col} = (0.75)*(0.87) = 0.65$$

where p_4 is the probability of his staying in service after the 4th year of the MVC if he had survived the MVC, and

$P_{Lt\ Col}$ is the probability (retention rate) of his staying in service after the 1st year as a Lt Col if he had survived the MVC

………….

$$P_6 = (p_{maj})^3 * (p_{Lt\ Col})^3 = (0.75)*(0.66) = 0.49$$

where p_6 is the probability of his staying in service after the 6th year of the MVC if he had survived the MVC, and

$(p_{Lt\ Col})^3$ is the probability (retention rate) of his staying in service after the 3rd year as a Lt Col if he had survived the MVC.

After the summation, the expected number of lost workdays for this death Major is: 220*4.2 = 924 days.

2nd Scenario

<u>Lost Work Days equal to the average time that AFPC needs to "replace" a military member because of an emergency like an MVC which causes either fatal or PT or P Dis injuries</u>

This study tried to estimate the average time the AFPC needs to find and send someone new to take over the position from the previous service member who had a serious MVC. This thesis, after a discussion with appropriate military personnel, estimates that an average of the above needed time is 6 months, independently of the rank. Therefore, the Lost Work Days of this scenario is a fixed number per rank and this number is equal to 6 months or 110 days.

Appendix C. Multiple Comparisons Output for the GEN*SEATB Interaction

Gen: FEMALE									Gen: MALE		
Seatb: NO (4W)			Seatb: YES (4W)			Seatb: Z (2W)			Seatb: NO (4W)		
DIFFERENCE OF LOST DAYS' MEAN			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**		
FEMALE & NO	<	FEMALE & YES	FEMALE & YES	<	FEMALE & 2W	FEMALE & 2W	>	MALE & NO	MALE & NO	<	MALE & YES
FEMALE & NO	<	FEMALE & 2W	FEMALE & YES	<	MALE & YES	FEMALE & 2W	>	MALE & YES	MALE & NO	<	MALE & 2W
FEMALE & NO	<	MALE & YES	FEMALE & YES	<	MALE & 2W						
FEMALE & NO	<	MALE & 2W									

***The above colored cell indicates that the difference in the mean is statistically significant at α = 0.05 significance level**

Appendix D. Multiple Comparisons Output for the RANK*INJ Interaction

Rank: AIRMAN											
Inj: FATALITY **DIFFERENCE OF LOST DAYS' MEAN**			**Inj: LOST TM CASE** **DIFFERENCE OF LOST DAYS' MEAN**			**Inj: MINOR INJ** **DIFFERENCE OF LOST DAYS' MEAN**			**Inj: PT or P DIS** **DIFFERENCE OF LOST DAYS' MEAN**		
AIRMAN & FATALITY	>	AIRMAN & LOST TIME CASE	AIRMAN & LOST TM CASE	>	AIRMAN & MINOR INJ	AIRMAN & MINOR INJ	<	AIRMAN & PT or P DIS	AIRMAN & PT or P DIS	>	COMP GRADE & LOST TM CASE
AIRMAN & FATALITY	>	AIRMAN & MINOR INJ	AIRMAN & LOST TM CASE	<	AIRMAN & PT or P DIS	AIRMAN & MINOR INJ	<	COMP GRADE & FATALITY	AIRMAN & PT or P DIS	>	COMP GRADE & MINOR INJ
AIRMAN & FATALITY	>	COMP GRADE & LOST TM CASE	AIRMAN & LOST TM CASE	<	COMP GRADE & FATALITY	AIRMAN & MINOR INJ	<	COMP GRADE & LOST TM CASE	AIRMAN & PT or P DIS	>	F & F GRADE & FATALITY
AIRMAN & FATALITY	>	COMP GRADE & MINOR INJ	AIRMAN & LOST TM CASE	>	COMP GRADE & MINOR INJ	AIRMAN & MINOR INJ	<	COMP GRADE & PT or P DIS	AIRMAN & PT or P DIS	>	F & F GRADE & LOST TM CASE
AIRMAN & FATALITY	>	F & F GRADE & FATALITY	AIRMAN & LOST TM CASE	<	COMP GRADE & PT or P DIS	AIRMAN & MINOR INJ	<	F & F GRADE & FATALITY	AIRMAN & PT or P DIS	>	F & F GRADE & MINOR INJ
AIRMAN & FATALITY	>	F & F GRADE & LOST TM CASE	AIRMAN & LOST TM CASE	<	F & F GRADE & FATALITY	AIRMAN & MINOR INJ	<	F & F GRADE & LOST TM CASE	AIRMAN & PT or P DIS	>	NCO & LOST TM CASE
AIRMAN & FATALITY	>	F & F GRADE & MINOR INJ	AIRMAN & LOST TM CASE	<	F & F GRADE & LOST TM CASE	AIRMAN & MINOR INJ	<	F & F GRADE & PT or P DIS	AIRMAN & PT or P DIS	>	NCO & MINOR INJ
AIRMAN & FATALITY	>	NCO & LOST TM CASE	AIRMAN & LOST TM CASE	<	F & F GRADE & PT or P DIS	AIRMAN & MINOR INJ	<	NCO & FATALITY	AIRMAN & PT or P DIS	>	SENIOR NCO & FATALITY
AIRMAN & FATALITY	>	NCO & MINOR INJ	AIRMAN & LOST TM CASE	<	NCO & FATALITY	AIRMAN & MINOR INJ	<	NCO & LOST TM CASE	AIRMAN & PT or P DIS	>	SENIOR NCO & LOST TM CASE
AIRMAN & FATALITY	>	SENIOR NCO & FATALITY	AIRMAN & LOST TM CASE	>	NCO & MINOR INJ	AIRMAN & MINOR INJ	<	NCO & PT or P DIS	AIRMAN & PT or P DIS	>	SENIOR NCO & MINOR INJ

AIRMAN & FATALITY	>	SENIOR NCO & LOST TM CASE	AIRMAN & LOST TM CASE	<	NCO & PT or P DIS	AIRMAN & MINOR INJ	<	SENIOR NCO & LOST TM CASE	AIRMAN & PT or P DIS	>	SENIOR NCO & PT or P DIS
AIRMAN & FATALITY	>	SENIOR NCO & MINOR INJ	AIRMAN & LOST TM CASE	>	SENIOR NCO & FATLITY	AIRMAN & MINOR INJ	<	SENIOR NCO & PT or P DIS			
AIRMAN & FATALITY	>	SENIOR NCO & PT or P DIS	AIRMAN & LOST TM CASE	>	SENIOR NCO & MINOR INJ						
			AIRMAN & LOST TM CASE	>	SENIOR NCO & PT or P DIS						

Rank: COMPANY GRADE

Inj: FATALITY			**Inj: LOST TM CASE**			**Inj: MINOR INJ**			**Inj: PT or P DIS**		
DIFFERENCE OF LOST DAYS' MEAN			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**		
COMP GRADE & FATALITY	>	COMP GRADE & LOST TM CASE	COMP GRADE & LOST TM CASE	>	COMP GRADE & MINOR INJ	COMP GRADE & MINOR INJ	<	COMP GRADE & PT or P DIS	COMP GRADE & PT or P DIS	>	F & F GRADE & FATALITY
COMP GRADE & FATALITY	>	COMP GRADE & MINOR INJ	COMP GRADE & LOST TM CASE	<	COMP GRADE & PT or P DIS	COMP GRADE & MINOR INJ	<	F & F GRADE & FATALITY	COMP GRADE & PT or P DIS	>	F & F GRADE & LOST TM CASE
COMP GRADE & FATALITY	>	F & F GRADE & FATALITY	COMP GRADE & LOST TM CASE	<	F & F GRADE & FATALITY	COMP GRADE & MINOR INJ	<	F & F GRADE & LOST TM CASE	COMP GRADE & PT or P DIS	>	F & F GRADE & MINOR INJ
COMP GRADE & FATALITY	>	F & F GRADE & LOST TM CASE	COMP GRADE & LOST TM CASE	<	F & F GRADE & LOST TM CASE	COMP GRADE & MINOR INJ	<	F & F GRADE & PT or P DIS	COMP GRADE & PT or P DIS	>	NCO & LOST TM CASE
COMP GRADE & FATALITY	>	F & F GRADE & MINOR INJ	COMP GRADE & LOST TM CASE	<	F & F GRADE & PT or P DIS	COMP GRADE & MINOR INJ	<	NCO & FATALITY	COMP GRADE & PT or P DIS	>	NCO & MINOR INJ
COMP GRADE & FATALITY	>	NCO & LOST TM CASE	COMP GRADE & LOST TM CASE	<	NCO & FATALITY	COMP GRADE & MINOR INJ	<	NCO & LOST TM CASE	COMP GRADE & PT or P DIS	>	SENIOR NCO & FATALITY
COMP GRADE & FATALITY	>	NCO & MINOR INJ	COMP GRADE & LOST TM CASE	>	NCO & MINOR INJ	COMP GRADE & MINOR INJ	<	NCO & PT or P DIS	COMP GRADE & PT or P DIS	>	SENIOR NCO & LOST TM CASE

COMP GRADE & FATALITY	>	SENIOR NCO & FATALITY	COMP GRADE & LOST TM CASE	<	NCO & PT or P DIS	COMP GRADE & MINOR INJ	<	SENIOR NCO & LOST TM CASE	COMP GRADE & PT or P DIS	>	SENIOR NCO & MINOR INJ
COMP GRADE & FATALITY	>	SENIOR NCO & LOST TM CASE	COMP GRADE & LOST TM CASE	>	SENIOR NCO & FATALITY				COMP GRADE & PT or P DIS	>	SENIOR NCO & PT or P DIS
COMP GRADE & FATALITY	>	SENIOR NCO & MINOR INJ	COMP GRADE & LOST TM CASE	>	SENIOR NCO & MINOR INJ						
COMP GRADE & FATALITY	>	SENIOR NCO & PT or P DIS	COMP GRADE & LOST TM CASE	>	SENIOR NCO & PT or P DIS						

Rank: FIELD & FLAG GRADE

Inj: FATALITY			Inj: LOST TM CASE			Inj: MINOR INJ			Inj: PT or P DIS		
DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN		
F & F GRADE & FATALITY	>	F & F GRADE & LOST TM CASE	F & F GRADE & LOST TM CASE	>	F & F GRADE & MINOR INJ	F & F GRADE & MINOR INJ	<	F & F GRADE & PT or P DIS	F & F GRADE & PT or P DIS	>	NCO & LOST TM CASE
F & F GRADE & FATALITY	>	F & F GRADE & MINOR INJ	F & F GRADE & LOST TM CASE	<	F & F GRADE & PT or P DIS	F & F GRADE & MINOR INJ	<	NCO & FATALITY	F & F GRADE & PT or P DIS	>	NCO & MINOR INJ
F & F GRADE & FATALITY	<	NCO & FATALITY	F & F GRADE & LOST TM CASE	<	NCO & FATALITY	F & F GRADE & MINOR INJ	<	NCO & PT or P DIS	F & F GRADE & PT or P DIS	>	SENIOR NCO & FATALITY
F & F GRADE & FATALITY	>	NCO & LOST TM CASE	F & F GRADE & LOST TM CASE	>	NCO & LOST TM CASE				F & F GRADE & PT or P DIS	>	SENIOR NCO & LOST TM CASE
F & F GRADE & FATALITY	>	NCO & MINOR INJ	F & F GRADE & LOST TM CASE	>	NCO & MINOR INJ				F & F GRADE & PT or P DIS	>	SENIOR NCO & MINOR INJ
F & F GRADE & FATALITY	<	NCO & PT or P DIS	F & F GRADE & LOST TM CASE	<	NCO & PT or P DIS				F & F GRADE & PT or P DIS	>	SENIOR NCO & PT or P DIS

F & F GRADE & FATALITY	>	SENIOR NCO & FATALITY	F & F GRADE & LOST TM CASE	>	SENIOR NCO & FATALITY						
F & F GRADE & FATALITY	>	SENIOR NCO & LOST TM CASE	F & F GRADE & LOST TM CASE	>	SENIOR NCO & LOST TM CASE						
F & F GRADE & FATALITY	>	SENIOR NCO & MINOR INJ	F & F GRADE & LOST TM CASE	>	SENIOR NCO & MINOR INJ						
F & F GRADE & FATALITY	>	SENIOR NCO & PT or P DIS	F & F GRADE & LOST TM CASE	>	SENIOR NCO & PT or P DIS						
Rank: NCO											
Inj: FATALITY			**Inj: LOST TM CASE**			**Inj: MINOR INJ**			**Inj: PT or P DIS**		
DIFFERENCE OF LOST DAYS' MEAN			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**		
NCO & FATALITY	>	NCO & LOST TM CASE	NCO & LOST TM CASE	>	NCO & MINOR INJ	NCO & MINOR INJ	<	NCO & PT or P DIS	NCO & PT or P DIS	>	SENIOR NCO & FATALITY
NCO & FATALITY	>	NCO & MINOR INJ	NCO & LOST TM CASE	<	NCO & PT or P DIS	NCO & MINOR INJ	<	SENIOR NCO & LOST TM CASE	NCO & PT or P DIS	>	SENIOR NCO & LOST TM CASE
NCO & FATALITY	>	SENIOR NCO & FATALITY	NCO & LOST TM CASE	>	SENIOR NCO & FATALITY				NCO & PT or P DIS	>	SENIOR NCO & MINOR INJ
NCO & FATALITY	>	SENIOR NCO & LOST TM CASE	NCO & LOST TM CASE	>	SENIOR NCO & MINOR INJ				NCO & PT or P DIS	>	SENIOR NCO & PT or P DIS
NCO & FATALITY	>	SENIOR NCO & MINOR INJ	NCO & LOST TM CASE	>	SENIOR NCO & PT or P DIS						
NCO & FATALITY	>	SENIOR NCO & PT or P DIS									
Rank: Senior NCO											
Inj: FATALITY			**Inj: LOST TM CASE**								

DIFFERENCE OF LOST DAYS' MEAN			**DIFFERENCE OF LOST DAYS' MEAN**								
SENIOR NCO & FATALITY	<	SENIOR NCO & LOST TM CASE	SENIOR NCO & LOST TM CASE	>	SENIOR NCO & MINOR INJ						
SENIOR NCO & FATALITY	<	SENIOR NCO & PT or P DIS	SENIOR NCO & LOST TM CASE	>	SENIOR NCO & PT or P DIS						

***The above colored cells indicate that the difference in the mean is statistically significant at α = 0.05 significance level**

Appendix E. Multiple Comparisons Output for the RANK*BAC Interaction

Rank: AIRMAN

BAC: 0.00			BAC: 0.01 - 0.07			BAC: 0.08 - 0.29		
DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN		
AIRMAN & 0.00	>	F & F GRADE & 0.00	AIRMAN & 0.01 - 0.07	>	F & F GRADE & 0.00	AIRMAN & 0.08 - 0.29	>	F & F GRADE & 0.00
AIRMAN & 0.00	>	SENIOR NCO & 0.00	AIRMAN & 0.01 - 0.07	>	SENIOR NCO & 0.00	AIRMAN & 0.08 - 0.29	>	SENIOR NCO & 0.00
AIRMAN & 0.00	>	SENIOR NCO & 0.01 - 0.07	AIRMAN & 0.01 - 0.07	>	SENIOR NCO & 0.01 - 0.07	AIRMAN & 0.08 - 0.29	>	SENIOR NCO & 0.01 - 0.07
AIRMAN & 0.00	>	SENIOR NCO & 0.08 - 0.29	AIRMAN & 0.01 - 0.07	>	SENIOR NCO & 0.08 - 0.29	AIRMAN & 0.08 - 0.29	>	SENIOR NCO & 0.08 - 0.29

Rank: COMPANY GRADE

BAC: 0.00			BAC: 0.01 - 0.07			BAC: 0.08 - 0.29		
DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN		
COMP GRADE & 0.00	>	F & F GRADE & 0.00	COMP GRADE & 0.01 -0.07	>	F & F GRADE & 0.00	COMP GRADE & 0.08 - 0.29	>	F & F GRADE & 0.00
COMP GRADE & 0.00	>	SENIOR NCO & 0.00	COMP GRADE & 0.01 -0.07	>	SENIOR NCO & 0.00	COMP GRADE & 0.08 - 0.29	>	SENIOR NCO & 0.00
COMP GRADE & 0.00	>	SENIOR NCO & 0.01 - 0.07	COMP GRADE & 0.01 -0.07	>	SENIOR NCO & 0.01 - 0.07	COMP GRADE & 0.08 - 0.29	>	SENIOR NCO & 0.01 - 0.07
COMP GRADE & 0.00	>	SENIOR NCO & 0.08 - 0.29	COMP GRADE & 0.01 -0.07	>	SENIOR NCO & 0.08 - 0.29	COMP GRADE & 0.08 - 0.29	>	SENIOR NCO & 0.08 - 0.29

Rank: FIELD & FLAG GRADE

BAC: 0.00			BAC: 0.01 - 0.07			BAC: 0.08 - 0.29		
DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN		
F & F GRADE & 0.00	<	F & F GRADE & 0.01 - 0.07	F & F GRADE & 0.01 - 0.07	>	SENIOR NCO & 0.00	F & F GRADE & 0.08 - 0.29	>	SENIOR NCO & 0.00
F & F GRADE & 0.00	<	F & F GRADE & 0.08 - 0.29	F & F GRADE & 0.01 - 0.07	>	SENIOR NCO & 0.01 - 0.07	F & F GRADE & 0.08 - 0.29	>	SENIOR NCO & 0.01 - 0.07

F & F GRADE & 0.00	<	NCO & 0.00	F & F GRADE & 0.01 - 0.07	>	SENIOR NCO & 0.08 - 0.29	F & F GRADE & 0.08 - 0.29	>	SENIOR NCO & 0.08 - 0.29
F & F GRADE & 0.00	<	NCO & 0.01 - 0.07						
F & F GRADE & 0.00	<	NCO & 0.08 - 0.29						
F & F GRADE & 0.00	>	SENIOR NCO & 0.00						
F & F GRADE & 0.00	>	SENIOR NCO & 0.08 - 0.29						
Rank: NCO								
BAC: 0.00			**BAC: 0.01 - 0.07**			**BAC: 0.08 - 0.29**		
DIFFERENCE OF LOST DAYS' MEAN			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**		
NCO & 0.00	>	SENIOR NCO & 0.00	NCO & 0.01 - 0.07	>	SENIOR NCO & 0.00	NCO & 0.08 - 0.29	>	SENIOR NCO & 0.00
NCO & 0.00	>	SENIOR NCO & 0.01 - 0.07	NCO & 0.01 - 0.07	>	SENIOR NCO & 0.01 - 0.07	NCO & 0.08 - 0.29	>	SENIOR NCO & 0.01 - 0.07
NCO & 0.00	>	SENIOR NCO & 0.08 - 0.29	NCO & 0.01 - 0.07	>	SENIOR NCO & 0.08 - 0.29	NCO & 0.08 - 0.29	>	SENIOR NCO & 0.08 - 0.29

***The above colored cells indicate that the difference in the mean is statistically significant at $\alpha = 0.05$ significance level**

Appendix F. Multiple Comparisons Output for the RANK*SEATB Interaction

Rank: AIRMAN

Seatb: NO (4W)

DIFFERENCE OF LOST DAYS' MEAN		
AIRMAN & NO	>	F & F GRADE & NO
AIRMAN & NO	>	SENIOR NCO & NO
AIRMAN & NO	>	SENIOR NCO & YES
AIRMAN & NO	>	SENIOR NCO & 2W

Seatb: YES (4W)

DIFFERENCE OF LOST DAYS' MEAN		
AIRMAN & YES	<	AIRMAN & 2W
AIRMAN & YES	>	SENIOR NCO & NO
AIRMAN & YES	>	SENIOR NCO & YES
AIRMAN & YES	>	SENIOR NCO & 2W

Seatb: Z (2W)

DIFFERENCE OF LOST DAYS' MEAN		
AIRMAN & 2W	>	F & F GRADE & NO
AIRMAN & 2W	>	SENIOR NCO & NO
AIRMAN & 2W	>	SENIOR NCO & YES
AIRMAN & 2W	>	SENIOR NCO & 2W

Rank: COMPANY GRADE

Seatb: NO (4W)

DIFFERENCE OF LOST DAYS' MEAN		
COMP GRADE & NO	>	SENIOR NCO & NO
COMP GRADE & NO	>	SENIOR NCO & YES
COMP GRADE & NO	>	SENIOR NCO & 2W

Seatb: YES (4W)

DIFFERENCE OF LOST DAYS' MEAN		
COMP GRADE & YES	>	SENIOR NCO & NO
COMP GRADE & YES	>	SENIOR NCO & YES
COMP GRADE & YES	>	SENIOR NCO & 2W

Seatb: Z (2W)

DIFFERENCE OF LOST DAYS' MEAN		
COMP GRADE & 2W	>	F & F GRADE & NO
COMP GRADE & 2W	>	SENIOR NCO & NO
COMP GRADE & 2W	>	SENIOR NCO & YES
COMP GRADE & 2W	>	SENIOR NCO & 2W

Rank: FIELD & FLAG GRADE

Seatb: NO (4W)

DIFFERENCE OF LOST DAYS' MEAN		
F & F GRADE & NO	<	F & F GRADE & YES
F & F GRADE & NO	<	F & F GRADE & 2W

Seatb: YES (4W)

DIFFERENCE OF LOST DAYS' MEAN		
F & F GRADE & YES	>	SENIOR NCO & NO
F & F GRADE & YES	>	SENIOR NCO & YES

Seatb: Z (2W)

DIFFERENCE OF LOST DAYS' MEAN		
F & F GRADE & 2W	>	SENIOR NCO & NO
F & F GRADE & 2W	>	SENIOR NCO & YES

F & F GRADE & NO	<	NCO & NO	F & F GRADE & YES	>	SENIOR NCO & 2W	F & F GRADE & 2W	>	SENIOR NCO & 2W
F & F GRADE & NO	<	NCO & 2W						
F & F GRADE & NO	>	SENIOR NCO & NO						
F & F GRADE & NO	>	SENIOR NCO & YES						
F & F GRADE & NO	>	SENIOR NCO & 2W						

Rank: NCO

Seatb: NO (4W)			Seatb: YES (4W)			Seatb: Z (2W)		
DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN		
NCO & NO	>	SENIOR NCO & NO	NCO & YES	<	NCO & 2W	NCO & 2W	>	SENIOR NCO & NO
NCO & NO	>	SENIOR NCO & YES	NCO & YES	>	SENIOR NCO & NO	NCO & 2W	>	SENIOR NCO & YES
NCO & NO	>	SENIOR NCO & 2W	NCO & YES	>	SENIOR NCO & YES	NCO & 2W	>	SENIOR NCO & 2W
			NCO & YES	>	SENIOR NCO & 2W			

***The above colored cells indicate that the difference in the mean is statistically significant at α = 0.05 significance level**

Appendix G. Multiple Comparisons Output for the INJ*BAC Interaction

Inj: FATALITY								
BAC: 0.00			BAC: 0.01 - 0.07			BAC: 0.08 - 0.29		
DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN		
FATALITY & 0.00	>	LOST TM CASE & 0.00	FATALITY & 0.01 - 0.07	>	LOST TM CASE & 0.00	FATALITY & 0.08 - 0.29	>	LOST TM CASE & 0.00
FATALITY & 0.00	>	LOST TM CASE & 0.01 - 0.07	FATALITY & 0.01 - 0.07	>	LOST TM CASE & 0.01 - 0.07	FATALITY & 0.08 - 0.29	>	LOST TM CASE & 0.01 - 0.07
FATALITY & 0.00	>	LOST TM CASE & 0.08 - 0.29	FATALITY & 0.01 - 0.07	>	LOST TM CASE & 0.08 - 0.29	FATALITY & 0.08 - 0.29	>	LOST TM CASE & 0.08 - 0.29
FATALITY & 0.00	>	MINOR INJ & 0.00	FATALITY & 0.01 - 0.07	>	MINOR INJ & 0.00	FATALITY & 0.08 - 0.29	>	MINOR INJ & 0.00
FATALITY & 0.00	>	MINOR INJ & 0.01 - 0.07	FATALITY & 0.01 - 0.07	>	MINOR INJ & 0.01 - 0.07	FATALITY & 0.08 - 0.29	>	MINOR INJ & 0.01 - 0.07
FATALITY & 0.00	>	MINOR INJ & 0.08 - 0.29	FATALITY & 0.01 - 0.07	>	MINOR INJ & 0.08 - 0.29	FATALITY & 0.08 - 0.29	>	MINOR INJ & 0.08 - 0.29
FATALITY & 0.00	<	PT or P DIS & 0.00						
FATALITY & 0.00	<	PT or P DIS & 0.08 - 0.29						

Inj: LOST TM CASE								
BAC: 0.00			BAC: 0.01 - 0.07			BAC: 0.08 - 0.29		
DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN		
LOST TM CASE & 0.00	<	LOST TM CASE & 0.01 - 0.07	LOST TM CASE & 0.01 – 0.07	>	MINOR INJ & 0.00	LOST TM CASE & 0.08 - 0.29	>	MINOR INJ & 0.00
LOST TM CASE & 0.00	<	LOST TM CASE & 0.08 - 0.29	LOST TM CASE & 0.01 – 0.07	>	MINOR INJ & 0.01 - 0.07	LOST TM CASE & 0.08 - 0.29	>	MINOR INJ & 0.01 - 0.07
LOST TM CASE & 0.00	>	MINOR INJ & 0.00	LOST TM CASE & 0.01 – 0.07	>	MINOR INJ & 0.08 - 0.29	LOST TM CASE & 0.08 - 0.29	>	MINOR INJ & 0.08 - 0.29
LOST TM CASE & 0.00	>	MINOR INJ & 0.01 - 0.07	LOST TM CASE & 0.01 – 0.07	<	PT or P DIS & 0.00	LOST TM CASE & 0.08 - 0.29	<	PT or P DIS & 0.00
LOST TM CASE & 0.00	>	MINOR INJ & 0.08 - 0.29	LOST TM CASE & 0.01 – 0.07	<	PT or P DIS & 0.01 - 0.07	LOST TM CASE & 0.08 - 0.29	<	PT or P DIS & 0.01 - 0.07
LOST TM CASE & 0.00	<	PT or P DIS & 0.00	LOST TM CASE & 0.01 – 0.07	<	PT or P DIS & 0.08 - 0.29	LOST TM CASE & 0.08 - 0.29	<	PT or P DIS & 0.08 - 0.29

LOST TM CASE & 0.00	<	PT or P DIS & 0.01 - 0.07						
LOST TM CASE & 0.00	<	PT or P DIS & 0.08 - 0.29						
Inj: MINOR INJ								
BAC: 0.00			**BAC: 0.01 - 0.07**			**BAC: 0.08 - 0.29**		
DIFFERENCE OF LOST DAYS' MEAN			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**		
MINOR INJ & 0.00	<	PT or P DIS & 0.00	MINOR INJ & 0.01 - 0.07	<	PT or P DIS & 0.00	MINOR INJ & 0.08 - 0.29	<	PT or P DIS & 0.00
MINOR INJ & 0.00	<	PT or P DIS & 0.01 - 0.07	MINOR INJ & 0.01 - 0.07	<	PT or P DIS & 0.01 - 0.07	MINOR INJ & 0.08 - 0.29	<	PT or P DIS & 0.01 - 0.07
MINOR INJ & 0.00	<	PT or P DIS & 0.08 - 0.29	MINOR INJ & 0.01 - 0.07	<	PT or P DIS & 0.08 - 0.29	MINOR INJ & 0.08 - 0.29	<	PT or P DIS & 0.08 - 0.29

***The above colored cells indicate that the difference in the mean is statistically significant at α = 0.05 significance level**

Appendix H. Multiple Comparisons Output for the INJ*SEATB Interaction

Inj: FATALITY								
Seatb: NO			Seatb: YES			Seatb: Z (2W)		
DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN		
FATALITY & NO	<	FATALITY & YES	FATALITY & YES	>	LOST TM CASE & NO	FATALITY & 2W	>	LOST TM CASE & NO
FATALITY & NO	<	FATALITY & 2W	FATALITY & YES	>	LOST TM CASE & YES	FATALITY & 2W	>	LOST TM CASE & YES
FATALITY & NO	>	LOST TM CASE & NO	FATALITY & YES	>	LOST TM CASE & 2W	FATALITY & 2W	>	LOST TM CASE & 2W
FATALITY & NO	>	LOST TM CASE & YES	FATALITY & YES	>	MINOR INJ & NO	FATALITY & 2W	>	MINOR INJ & NO
FATALITY & NO	>	LOST TM CASE & 2W	FATALITY & YES	>	MINOR INJ & YES	FATALITY & 2W	>	MINOR INJ & YES
FATALITY & NO	>	MINOR INJ & NO	FATALITY & YES	>	MINOR INJ & 2W	FATALITY & 2W	>	MINOR INJ & 2W
FATALITY & NO	>	MINOR INJ & YES	FATALITY & YES	<	PT or P DIS & 2W			
FATALITY & NO	>	MINOR INJ & 2W						
FATALITY & NO	<	PT or P DIS & YES						
FATALITY & NO	<	PT or P DIS & 2W						

Inj: LOST TM CASE								
Seatb: NO			Seatb: YES			Seatb: Z (2W)		
DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN		
LOST TM CASE & NO	<	LOST TM CASE & 2W	LOST TM CASE & YES	<	LOST TM CASE & 2W	LOST TM CASE & 2W	>	MINOR INJ & NO
LOST TM CASE & NO	>	MINOR INJ & NO	LOST TM CASE & YES	>	MINOR INJ & NO	LOST TM CASE & 2W	>	MINOR INJ & YES
LOST TM CASE & NO	>	MINOR INJ & YES	LOST TM CASE & YES	>	MINOR INJ & YES	LOST TM CASE & 2W	>	MINOR INJ & 2W
LOST TM CASE & NO	>	MINOR INJ & 2W	LOST TM CASE & YES	>	MINOR INJ & 2W	LOST TM CASE & 2W	<	PT or P DIS & NO

LOST TM CASE & NO	<	PT or P DIS & NO	LOST TM CASE & YES	<	PT or P DIS & NO	LOST TM CASE & 2W	<	PT or P DIS & YES
LOST TM CASE & NO	<	PT or P DIS & YES	LOST TM CASE & YES	<	PT or P DIS & YES	LOST TM CASE & 2W	<	PT or P DIS & 2W
LOST TM CASE & NO	<	PT or P DIS & 2W	LOST TM CASE & YES	<	PT or P DIS & 2W			

Inj: MINOR INJ

Seatb: NO			Seatb: YES			Seatb: Z (2W)		
DIFFERENCE OF LOST DAYS' MEAN			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**		
MINOR INJ & NO	<	MINOR INJ & YES	MINOR INJ & YES	<	PT or P DIS & NO	MINOR INJ & 2W	<	PT or P DIS & NO
MINOR INJ & NO	<	MINOR INJ & 2W	MINOR INJ & YES	<	PT or P DIS & YES	MINOR INJ & 2W	<	PT or P DIS & YES
MINOR INJ & NO	<	PT or P DIS & NO	MINOR INJ & YES	<	PT or P DIS & 2W	MINOR INJ & 2W	<	PT or P DIS & 2W
MINOR INJ & NO	<	PT or P DIS & YES						
MINOR INJ & NO	<	PT or P DIS & 2W						

Inj: PT or P DIS

Seatb: NO		
DIFFERENCE OF LOST DAYS' MEAN		
PT or P DIS & NO	<	PT or P DIS & 2W

***The above colored cell indicates that the difference in the mean is statistically significant at α = 0.05 significance level**

Appendix I. Multiple Comparisons Output for the GEN*SEATB Interaction

Gen: FEMALE									Gen: MALE		
Seatb: NO (4W)			Seatb: YES (4W)			Seatb: Z (2W)			Seatb: YES (4W)		
DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN			DIFFERENCE OF LOST DAYS' MEAN		
FEMALE & NO	<	FEMALE & 2W	FEMALE & YES	<	FEMALE & 2W	FEMALE & 2W	>	MALE & YES	MALE & YES	<	MALE & 2W
			FEMALE & YES	<	MALE & NO						
			FEMALE & YES	<	MALE & YES						
			FEMALE & YES	<	MALE & 2W						

***The above colored cell indicates that the difference in the mean is statistically significant at α = 0.05 significance level**

Appendix J. Multiple Comparisons Output for the INJ*BAC Interaction

Inj: FATALITY

BAC: 0.00

DIFFERENCE OF LOST DAYS' MEAN		
FATALITY & 0.00	>	LOST TM CASE & 0.00
FATALITY & 0.00	>	LOST TM CASE & 0.01 - 0.07
FATALITY & 0.00	>	LOST TM CASE & 0.08 - 0.29
FATALITY & 0.00	>	MINOR INJ & 0.00
FATALITY & 0.00	>	MINOR INJ & 0.01 - 0.07
FATALITY & 0.00	>	MINOR INJ & 0.08 - 0.29

BAC: 0.01 - 0.07

DIFFERENCE OF LOST DAYS' MEAN		
FATALITY & 0.01 - 0.07	>	LOST TM CASE & 0.00
FATALITY & 0.01 - 0.07	>	LOST TM CASE & 0.01 - 0.07
FATALITY & 0.01 - 0.07	>	LOST TM CASE & 0.08 - 0.29
FATALITY & 0.01 - 0.07	>	MINOR INJ & 0.00
FATALITY & 0.01 - 0.07	>	MINOR INJ & 0.01 - 0.07
FATALITY & 0.01 - 0.07	>	MINOR INJ & 0.08 - 0.29

BAC: 0.08 - 0.29

DIFFERENCE OF LOST DAYS' MEAN		
FATALITY & 0.08 - 0.29	>	LOST TM CASE & 0.00
FATALITY & 0.08 - 0.29	>	LOST TM CASE & 0.01 - 0.07
FATALITY & 0.08 - 0.29	>	LOST TM CASE & 0.08 - 0.29
FATALITY & 0.08 - 0.29	>	MINOR INJ & 0.00
FATALITY & 0.08 - 0.29	>	MINOR INJ & 0.01 - 0.07
FATALITY & 0.08 - 0.29	>	MINOR INJ & 0.08 - 0.29

Inj: LOST TM CASE

BAC: 0.00

DIFFERENCE OF LOST DAYS' MEAN		
LOST TM CASE & 0.00	<	LOST TM CASE & 0.01 - 0.07
LOST TM CASE & 0.00	<	LOST TM CASE & 0.08 - 0.29
LOST TM CASE & 0.00	>	MINOR INJ & 0.00
LOST TM CASE & 0.00	>	MINOR INJ & 0.01 - 0.07
LOST TM CASE & 0.00	>	MINOR INJ & 0.08 - 0.29
LOST TM CASE & 0.00	<	PT or P DIS & 0.00
LOST TM CASE & 0.00	<	PT or P DIS & 0.01 - 0.07

BAC: 0.01 - 0.07

DIFFERENCE OF LOST DAYS' MEAN		
LOST TM CASE & 0.01 - 0.07	>	MINOR INJ & 0.00
LOST TM CASE & 0.01 - 0.07	>	MINOR INJ & 0.01 - 0.07
LOST TM CASE & 0.01 - 0.07	>	MINOR INJ & 0.08 - 0.29
LOST TM CASE & 0.01 - 0.07	<	PT or P DIS & 0.00
LOST TM CASE & 0.01 - 0.07	<	PT or P DIS & 0.01 - 0.07
LOST TM CASE & 0.01 - 0.07	<	PT or P DIS & 0.08 - 0.29

BAC: 0.08 - 0.29

DIFFERENCE OF LOST DAYS' MEAN		
LOST TM CASE & 0.08 - 0.29	>	MINOR INJ & 0.00
LOST TM CASE & 0.08 - 0.29	>	MINOR INJ & 0.01 - 0.07
LOST TM CASE & 0.08 - 0.29	>	MINOR INJ & 0.08 - 0.29
LOST TM CASE & 0.08 - 0.29	<	PT or P DIS & 0.00
LOST TM CASE & 0.08 - 0.29	<	PT or P DIS & 0.01 - 0.07
LOST TM CASE & 0.08 - 0.29	<	PT or P DIS & 0.08 - 0.29

LOST TM CASE & 0.00	<	PT or P DIS & 0.08 - 0.29						
Inj: MINOR INJ								
BAC: 0.00			**BAC: 0.01 - 0.07**			**BAC: 0.08 - 0.29**		
DIFFERENCE OF LOST DAYS' MEAN			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**		
MINOR INJ & 0.00	<	PT or P DIS & 0.00	MINOR INJ & 0.01 - 0.07	<	PT or P DIS & 0.00	MINOR INJ & 0.08 - 0.29	<	PT or P DIS & 0.00
MINOR INJ & 0.00	<	PT or P DIS & 0.01 - 0.07	MINOR INJ & 0.01 - 0.07	<	PT or P DIS & 0.01 - 0.07	MINOR INJ & 0.08 - 0.29	<	PT or P DIS & 0.01 - 0.07
MINOR INJ & 0.00	<	PT or P DIS & 0.08 - 0.29	MINOR INJ & 0.01 - 0.07	<	PT or P DIS & 0.08 - 0.29	MINOR INJ & 0.08 - 0.29	<	PT or P DIS & 0.08 - 0.29

Appendix K. Multiple Comparisons Output for the INJ*SEATB Interaction

Inj: FATALITY								
Seatb: NO			**Seatb: YES**			**Seatb: Z (2W)**		
DIFFERENCE OF LOST DAYS' MEAN			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**		
FATALITY & NO	>	LOST TM CASE & NO	FATALITY & YES	>	LOST TM CASE & NO	FATALITY & 2W	>	LOST TM CASE & NO
FATALITY & NO	>	LOST TM CASE & YES	FATALITY & YES	>	LOST TM CASE & YES	FATALITY & 2W	>	LOST TM CASE & YES
FATALITY & NO	>	LOST TM CASE & 2W	FATALITY & YES	>	LOST TM CASE & 2W	FATALITY & 2W	>	LOST TM CASE & 2W
FATALITY & NO	>	MINOR INJ & NO	FATALITY & YES	>	MINOR INJ & NO	FATALITY & 2W	>	MINOR INJ & NO
FATALITY & NO	>	MINOR INJ & YES	FATALITY & YES	>	MINOR INJ & YES	FATALITY & 2W	>	MINOR INJ & YES
FATALITY & NO	>	MINOR INJ & 2W	FATALITY & YES	>	MINOR INJ & 2W	FATALITY & 2W	>	MINOR INJ & 2W

Inj: LOST TM CASE								
Seatb: NO			**Seatb: YES**			**Seatb: Z (2W)**		
DIFFERENCE OF LOST DAYS' MEAN			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**		
LOST TM CASE & NO	>	LOST TM CASE & YES	LOST TM CASE & YES	<	LOST TM CASE & 2W	LOST TM CASE & 2W	>	MINOR INJ & NO
LOST TM CASE & NO	<	LOST TM CASE & 2W	LOST TM CASE & YES	>	MINOR INJ & NO	LOST TM CASE & 2W	>	MINOR INJ & YES
LOST TM CASE & NO	>	MINOR INJ & NO	LOST TM CASE & YES	>	MINOR INJ & YES	LOST TM CASE & 2W	>	MINOR INJ & 2W
LOST TM CASE & NO	>	MINOR INJ & YES	LOST TM CASE & YES	>	MINOR INJ & 2W	LOST TM CASE & 2W	<	PT or P DIS & NO
LOST TM CASE & NO	>	MINOR INJ & 2W	LOST TM CASE & YES	<	PT or P DIS & NO	LOST TM CASE & 2W	<	PT or P DIS & YES

LOST TM CASE & NO	<	PT or P DIS & NO	LOST TM CASE & YES	<	PT or P DIS & YES	LOST TM CASE & 2W	<	PT or P DIS & 2W
LOST TM CASE & NO	<	PT or P DIS & YES	LOST TM CASE & YES	<	PT or P DIS & 2W			
LOST TM CASE & NO	<	PT or P DIS & 2W						
Inj: MINOR INJ								
Seatb: NO			**Seatb: YES**			**Seatb: Z (2W)**		
DIFFERENCE OF LOST DAYS' MEAN			**DIFFERENCE OF LOST DAYS' MEAN**			**DIFFERENCE OF LOST DAYS' MEAN**		
MINOR INJ & NO	<	PT or P DIS & NO	MINOR INJ & YES	<	PT or P DIS & NO	MINOR INJ & 2W	<	PT or P DIS & NO
MINOR INJ & NO	<	PT or P DIS & YES	MINOR INJ & YES	<	PT or P DIS & YES	MINOR INJ & 2W	<	PT or P DIS & YES
MINOR INJ & NO	<	PT or P DIS & 2W	MINOR INJ & YES	<	PT or P DIS & 2W	MINOR INJ & 2W	<	PT or P DIS & 2W

Bibliography

Air Force Institute of Technology (AFIT)/Safety Center (SC), *"101 Critical Days of Summer 06 – Recreational Planning,"* Electronic Message, 25 August 2008.

Air Force Personnel Center (AFPC). *"Air Force Demographics,"* 30 June 2008. 17 October 2008. http://www.afpc.randolph.af.mil/library/airforcepersonnelstatistics.asp

Air Force Personnel Center (AFPC). *"Air Force Personnel Statistics,"* 15 August 2008. http://wwa.afpc.randolph.af.mil/demographics/nu_demos/Regular_Enlisted_Average_Age_MYOS_TOS_Rank_Gender.pdf

Air Force Safety Center (AFSC), *"Air Force's Intervention Programs,"* Electronic Message, 06 August 2008.

Air Force Safety Center (AFSC), *"Descriptive Epidemiology Analysis of Active Duty Military Off-Duty Fatalities FY05-07,"* October 2007. Electronic Message, 06 August 2008.

Air Force Safety Center (AFSC), *"2008_101_CDS_Wrap-up_24 Sep08,"* Electronic Message, 09 October 2008.

Alcohol Policy Information System (APIS). *"Blood Alcohol Concentration Limits: Adult Operators of Noncommercial Motor Vehicles,"* 09 Aug 2008. http://alcoholpolicy.niaaa.nih.gov/index.asp?SEC={85AC5A78-16B8-444A-95BE-BA2A10EEE53A}&Type=BAS_APIS

American Association of State Highway and Transportation Officials (AASHTO). *"AASHTO Strategic Highway Safety Plan,"* 07 August 2008. http://safety.transportation.org/doc/Safety-StrategicHighwaySafetyPlan.pdf

Bridget, K. Carr. *"Fatal and Severe Injury Motor Vehicle Crashes Involving Air Force Personnel, 1988 – 1999."* Air Command and Staff College Air University Maxwell AFB, AL. A Research Report No AU/ACSC/ 038/ 2001 – 04, 01 Apr 2001.

Castle James, David Lynam, Jennifer Martin, Stephen D Lawson and Norbert Klassen. *"Star Rating Europe's Roads for Safety,"* Institute of Advanced Motorists (IAM). IAM Motoring Trust Report, December 2007. 03 August 2008. http://www.iam.org.uk/NR/rdonlyres/76EC40E8-F085-4AF4-AE2F-76169E5FFE07/0/EuroRAPreportPDF.pdf

Chipman, L. Mary, Carolyn G. MacGregor, Alison M. Smiley, and Martin Lee-Gosselin. *"The Role of Exposure in Comparisons of Crash Risk among Different Drivers and Driving Environments,"* Accid. Anal. & Prev, 25: 207-211, 1993.

Department of the Air Force, *"Safety Investigations & Reports,"* AFI 91-204. HQ USAF, 24 September 2008.

Department of Defense (DoD). *"Accident Investigation, Reporting, and Record Keeping."* DoD Instruction; No 6055.07, 24 April 2008.

Department of Defense (DoD). *"Atlas of Injuries in the U.S. Armed Forces: A Report by the DOD Injury Surveillance and Prevention Work Group for the Assistant Deputy Under Secretary of Defense for Safety and Occupational Health."* Technical Report; 1992 – 1999, No 29 – HE – 5454 – 99. Supplement to Military Medicine, August 1999.

Efron Bradley & Robert J. Tibshirani. *"An Introduction to the Bootstrap,"* Chapman & Hall, 1993

Evans, L. *"A New Traffic safety Vision for the United States,"* American Journal of Public Health, 93: 1384-1386, September 2003.

Evans, L. *"Evans responds,"* American Journal of Public Health, 94: 171-172, February 2004.

Evans L. Online! *"Traffic Safety and the Driver,"* Van Nostrand Reinhold, 1991. 01 Aug 08 http://books.google.com/books?id=OyuGJJ6rKQ0C&dq=Traffic+safety+and+the+driver&pg=PP1&ots=zqeijgjjBA&sig=gjzo9cHoNR-CRXCV-FaLIZcmg8U&hl=en&sa=X&oi=book_result&resnum=1&ct=result

Federal Highway Administration, (FHWA) Policy Information, *"Drivers and Driver Licensing*." 22 February 2009. http://www.fhwa.dot.gov/policy/ohpi/qfdrivers.cfm

Federal Highway Administration, (FHWA) *"Synthesis of Safety Research Related to Speed and Speed Limits"*. U.S." 22 August 2008 http://www.tfhrc.gov/safety/speed/speed.htm

Fricker Ronald. *"Statistical Methods for Policy Analysis,"* Rand Corporation, 21 September 2004.

General Accounting Office (GAO). *"Highway Safety: Research Continues on a Variety of Factors That Contribute to Motor Vehicle Crashes,"* Washington: GAO-03-436, March 2003.

Headquarters Air Force/Deputy Chief of Staff for Manpower and Personnel/Force Management Policy Directorate/Force Management Division (AF/A1), *"Retention Data,"* Electronic Message, 03 December 2008.

Jonah, A. Brian. *"Accident Risk and Risk-Taking Behaviour among Young Drivers,"* Accid. Anal. & Prev, 18: 255-271, 1986.

Jones, Bruce H, Dennis M. Perrotta, Michelle L. Canham-Chervak, Mary Anne Nee, and John F. Brundage. *"Injuries in the Military A Review and Commentary Focused on Prevention,"* Am J Prev Med, 18: 71-84, 2000.

Institute of Advanced Motorists (IAM). IAM Motoring Trust, *"Rural Roads report,"* 02 August 2008. http://www.iam.org.uk/motoringtrust/ http://www.iam.org.uk/NR/rdonlyres/8C560454-DE06-4E50-885B-FB92A09BE0E5/0/RuralRoadsReport.pdf

Kontogiannis, Tom, Zoe Kossiavelou, and Nicolas Marmaras. *"Self-reports of aberrant behaviour on the roads: errors and violations in a sample of Greek drivers,"* Accident Analysis & Prevention, 34: 381-399, 2002.

Ken, Thomas. *"US to Require Anti-Rollover Technology on New Cars by 2012,"* Insurance Journal, 15 September 2006. 23 August 2008. http://www.insurancejournal.com/news/national/2006/09/15/72448.htm

Lam, Lawrence T. *"Environmental factors associated with crash-related mortality and injury among taxi drivers in New South Wales, Australia,"* Accident Analysis & Prevention, 36: 905-908, 2004.

Lum, Harry, and Jerry A. Reagan. *"Interactive Highway Safety Design Model: Accident Predictive Module,"* Public Roads Magazine, 58; Winder 1995. 24 April 2008. http://www.tfhrc.gov/pubrds/winter95/p95wi14.htm

Mao, Yang, Jun Zhang, Glenn Robbins, Kathy Clarke, Miu Lam, and William Pickett. *"Factors affecting the severity of motor vehicle traffic crashes involving young drivers in Ontario,"* Injury Prevention, 3: 183-189, 1997.

Massie, Dawn L., Kenneth L. Campbell, and Allan F. Williams. *"Traffic Accidents Involvement Rates by Driver Age and Gender,"* Accid. Anal. & Prev, 27: 73-87, 1995.

Mayou, Richard, Bridget Bryant, and Anke Ehlers. *"Prediction of Rsychological Outcomes One Year After a Motor Vehicle Accident,"* Am J Psychiatry, 158: 1231-1238, 8, August 2001.

McClave, James T., P. George Benson, Terry Sincich, *"Statistics For Business and Economics,"* (Tenth edition). New Jersey: Pearson, Prentice Hall, 2008.

McKay, Mary Pat. *"Traffic safety in the United States,"* American Journal of Public Health, 94: 170-171, February 2004.

McNichol, Tom. *"Road Gone Wild,"* WIRED magazine, 12.12, December 2004. 23 August 2008. http://www.wired.com/wired/archive/12.12/traffic.html

National Highway Traffic Safety Administration (NHTSA). *"Analysis of Speeding-Related Fatal Motor Vehicle Traffic Cradhes,"* Technical Report DOT HS 809-839, June 2005. 14 August 2008. http://www-nrd.nhtsa.dot.gov/Pubs/809839.PDF

National Highway Traffic Safety Administration (NHTSA). *"Benefits of Safety Belts and Motorcycle Helmets,"* Report to Congress DOT HS 808-347, February 1996. 05 August 2008. http://www-nrd.nhtsa.dot.gov/Pubs/808-347.PDF

National Highway Traffic Safety Administration (NHTSA)/Crashworthiness Data System (CDS), CDS's Official Website. 03 August 2008. http://www.nhtsa-tsis.net/projects/NHTSA/NHTSA_CDS.htm

National Highway Traffic Safety Administration (NHTSA). *"Fatalities and Fatality Rates in Alcohol-Impaired Crashes by State, 2005-2006,"* Traffic Safety Facts, Research Note DOT HS 810-920, February 2008. 31 July 2008. http://www-nrd.nhtsa.dot.gov/Pubs/810920.PDF

National Highway Traffic Safety Administration (NHTSA)/Fatality Analysis Reporting System (FARS), FARS's Official Website. 03 August 2008. http://www.nhtsa-tsis.net/projects/NHTSA/NHTSA_FARS.htm

National Highway Traffic Safety Administration (NHTSA)/General Estimates System (GES), GES's Official Website. 03 August 2008. http://www.nhtsa-tsis.net/projects/NHTSA/NHTSA_GES.htm

National Highway Traffic Safety Administration (NHTSA). *"Motor Vehicle Traffic Crashes As a Leading Cause in the United States, 2005,"* Traffic Safety Facts Research Note DOT HS 810-936, April 2008. 30 June 2008. http://www-nrd.nhtsa.dot.gov/Pubs/810936.PDF

National Highway Traffic Safety Administration (NHTSA). *"Motorcycle Helmet Use in 2007-Overall Results,"* Traffic Safety Facts, Research Note DOT HS 810-840, August 2007. 03 August 2008. http://www-nrd.nhtsa.dot.gov/Pubs/810840.PDF

National Highway Traffic Safety Administration (NHTSA). *"Motorcycles,"* Traffic Safety Facts, 2005 Data, DOT HS 810-620, 2006. 29 July 2008. http://www-nrd.nhtsa.dot.gov/Pubs/810620.PDF

National Highway Traffic Safety Administration (NHTSA), NHTSA's Official Website. 10 August 2008.
http://www.nhtsa.dot.gov/

National Highway Traffic Safety Administration (NHTSA). *"Occupant Protection,"* Traffic Safety Facts, 2005 Data, DOT HS 810-621, 2006. 29 July 2008.
http://www-nrd.nhtsa.dot.gov/Pubs/810621.PDF

National Highway Traffic Safety Administration (NHTSA). *"Passenger Vehicle Occupant Fatalities by Day and Night-A Contrast,"* Traffic Safety Facts, Research Note DOT HS 810-637, May 2007. 13 August 2008.
http://www-nrd.nhtsa.dot.gov/Pubs/810637.PDF

National Highway Traffic Safety Administration (NHTSA). *"Seat Belt Use in 2007-Demographic Results,"* Traffic Safety Facts, Research Note DOT HS 810-932, April 2008. 08 August 2008.
http://www-nrd.nhtsa.dot.gov/Pubs/810932.PDF

National Highway Traffic Safety Administration (NHTSA). *"State Traffic Data,"* Traffic Safety Facts, 2006 Data, DOT HS 810-816, 2007. 30 July 2008.
http://www-nrd.nhtsa.dot.gov/Pubs/810816.PDF

National Highway Traffic Safety Administration (NHTSA). *"Statistical Analysis of Alcohol-Related Driving Trends, 1982-2005,"* Technical Report DOT HS 810-942, May 2008. 08 August 2008.
http://www-nrd.nhtsa.dot.gov/Pubs/810942.PDF

National Highway Traffic Safety Administration (NHTSA). *"The Economic Impact of Motor Vehicle Crashes, 2000,"* Technical Report DOT HS 809-446, May 2002. 30 June 2008.
http://www-nrd.nhtsa.dot.gov/Pubs/809446.PDF

National Highway Traffic Safety Administration (NHTSA). *"Traffic Safety Facts 2006,"* Annual Report (Final Edition) DOT HS 810-818, 2007. 22 December 2008.
http://www-nrd.nhtsa.dot.gov/Pubs/TSF2006FE.PDF

National Highway Traffic Safety Administration (NHTSA). *"Trend and Pattern Analysis of Highway Crash Fatality By Month and Day,"* Technical Report DOT HS 809-855, March 2005. 18 August 2008.
http://www-nrd.nhtsa.dot.gov/Pubs/809855.PDF

National Sleep Foundation. Waking America to the Importance of Sleep, *"Drowsy Driving"* 03 August 2008.
http://www.sleepfoundation.org/site/apps/nlnet/content.aspx?c=huIXKjM0IxF&b=2462623&ct=3498785

National Sleep Foundation. Waking America to the Importance of Sleep, *"Sleep Drive and Your Internal Body Clock,"* 03 August 2008. http://www.sleepfoundation.org/site/c.huIXKjM0IxF/b.2419129/k.23A7/Sleep_Drive_and_Your_Internal_Body_Clock.htm

National Household Travel Survey (NHTS), *"VMT*AGE,"* Electronic Message, 29 January 2009.

Office of Secretary of Defense, Information Delivery System, 2008

Ohio Department of Public Safety. *"Digest of Ohio Motor Vehicle Laws,"* 16 August 2008: Sec3:36. http://www.bmv.ohio.gov/pdf_forms/HSY-7607.pdf

Perneger, Thomas and Gordon S. Smith. *"The Driver's Role in Fatal Two-Car Crashes: A paired "Case-Control" Study,"* American Journal of Epidemiology, 134: 1138-1145, 1991.

Pless B., *"Road traffic injury prevention,"* BMJ, 328: 846, 2004.

Rumar, K. *"The role of perceptual and cognitive failures in observed behaviour."* In: Evans, L., Schwing, R.C. (Eds.), Human Behaviour and Traffic Safety. Plenum Press, New York, pp. 151–165, 1985.

Times on Line, *"Hans Monderman,"* 11 January 2008. 27 September 2008. http://www.timesonline.co.uk/tol/comment/obituaries/article3167372.ece

University of North Carolina. Highway Safety Research Center, *"Blood Alcohol Concentration (BAC),"* 05 August 2008. http://www.hsrc.unc.edu/safety_info/alcohol/blood_alcohol_concentration.cfm

Vernick, S. Jon and Stephen P. Teret. *"Making vehicles safer,"* American Journal of Public Health, 94: 170, February 2004.

Virginia Polytechnic Institute & State University (Virginia Tech), *"Alcohol's Effects,"* 07 December 2008. http://www.alcohol.vt.edu/Students/alcoholEffects/index.htm

Wikipedia/Automobile Safety, 18 August 2008. 19 August 2008. http://en.wikipedia.org/wiki/Automobile_safety

Wikipedia/Car Accident, 28 May 2008. 25 June 2008. http://en.wikipedia.org/wiki/Car_accident

Wikipedia/National Highway Traffic Administration (NHTSA), 28 July 2008. 04 August 2008. http://en.wikipedia.org/wiki/NHTSA

World Health Organization (WHO). WHO's Official Website, 30 May 2008. http://www.who.int/en/

World Health Organization (WHO). "*Road Safety: a public health issue*." 29 March 2004. 30 May 2008. http://www.who.int/features/2004/road_safety/en/

World Health Organization (WHO). *"World Health Statistics 2008,"* Part 1, 29-30, 20 May 2008. 14 August 2008. http://www.who.int/whosis/whostat/2008/en/index.html http://www.who.int/whosis/whostat/EN_WHS08_Part1.pdf

World Health Organization (WHO). "*World report on road traffic injury prevention* 2004," 30 May 2008. http://whqlibdoc.who.int/publications/2004/9241562609.pdf

Zhang J, S Fraser, J Lindsay, K Clarke and Y Mao. *"Age-specific patterns of factors related to fatal motor vehicle traffic crashes: focus on young and elderly drivers,"* Public Health, 112: 289-295, 1998.

Zlatoper, J. Thomas. *"Determinants of Motor Vehicles Deaths in the United States: a Cross-Sectional Analysis,"* Accid. Anal. & Prev, 23: 431-436, 1991.

Vita

First Lieutenant Antonios Markopoulos was born in Melbourne, Australia. He is an Officer in the Hellenic Air Force. He graduated from the Lyceum in Thouria - Messinias, Greece and enrolled in the Hellenic Officers Military Academy in 1995. He graduated with a Bachelor in Economics from the School of Law and Economics in Aristotle's University of Thessalonica, Greece in 1999 and was assigned to the Hellenic Air Force/ 134 Squadron at Santorini, Greece as an Accounting and Finance Officer until 2003.

From 2003 to 2005, he was assigned to the 115 Combat Wing Chania, Greece Finance Office where he performed the following duties:

a. 2003 to 2004, Accounting and Finance Officer

b. 2004 to 2005, Assistant to Economic Director.

From 2005 to 2007, he assigned to the NATO MISSILE FIRING INSTALLATION (NAMFI) Chania, Greece as a Chief of Budget Branch.

In September of 2007, First Lieutenant Antonios Markopoulos entered the Cost Analysis Master's Program at the Air Force Institute of Technology's School of Engineering and Management. Upon graduation, he will be assigned to the Hellenic Air Force General Staff.

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 074-0188*

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From – To)*
09-09-2009	Master's Thesis	Sep 2007 – Sep 2009

4. TITLE AND SUBTITLE

Analysis and Modeling of Motor Vehicle Crashes Involving Air Force Military Personnel

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Markopoulos, Antonios, First Lieutenant, Hellenic Air Force (HAF)

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)

Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 Hobson Way
WPAFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT/GCA/ENV/09-S01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Air Force Safety Center (AFSC)
Mr. Thomas L. Schultz
Mishap Research & Epidemiology
HQ AFSC/SEAR
9700 G Ave, Bldg 24499, Kirtland AFB NM 87117-5670 Phone: 505-846-0823

10. SPONSOR/MONITOR'S ACRONYM(S)

AFSC/SEAR

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The primary purpose of this thesis was to improve the data analysis of Motor Vehicle Crashes (MVCs). This thesis employed the Air Force Safety Center (AFSC) data, collected over 20 years, of MVCs in which US Air Force (USAF) military personnel are involved when off duty and off base. Categorical Data Analysis and Analysis of Variance (ANOVA) were applied to identify risk factors related to MVCs and influence the severity of injuries and those factors associated with the alcohol consumption before driving, and affect the number of lost workdays resulting from MVCs.

Categorical Data Analysis showed that male USAF members aged 17-24 years or with the rank of Airman were more prone to experience a fatal MVC. Moreover, fatal MVCs peaked between the hours of 2200 pm to 0559 am, and USAF female drivers seemed to wear seatbelts more than USAF male drivers. These thesis results revealed the value of wearing seatbelts for the prevention of severe injuries during crashes. Finally, ANOVA results exposed that the more severe the Type of Injury, the greater the number of Lost Days and that 2-wheeled vehicle MVCs have the most significant effect on the number of Lost Days.

15. SUBJECT TERMS

Motor Vehicle Crash, Risk of Motor Vehicle Crash, Injury Severity, Alcohol Consumption, Lost Workdays

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Jeremy M. Slagley, Maj, USAF
U	U	U	UU	183	**19b. TELEPHONE NUMBER** *(Include area code)* 937-785-3636x4511

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

Form Approved
OMB No. 074-0188